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OF

GENERAL SCIENCE,

BY

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VOL. I.

LONDON:

JOHN TAYLOR, 30, UPPER GOWER STREET,

Bookseller and Publisher to the University of London; and

SOLD BY MACLACHLAN AND STEWART, EDINBURGH; JOHN REID AND CO., AND RUTHERGLEN AND CO., GLASGOW; WAKEMAN, DUBLIN; KING AND CO., CORK; GRAPEL, LIVERPOOL; WEBB & SIMMS, MANCHESTER; AND BARLOW, BIRMINGHAM.

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ADVERTISEMENT.

The First Volume of the Records of General Science being now completed, it appears not unappropriate to take a retrospect of its contents.

These may be classed under four heads :

1. Original communications. Of this class of papers the volume contains no less than twenty eight; three of which are descriptive, upon a new plan, of calico-printing, one of the most important and beautiful manufactures in this country. Eight are devoted to accounts of 12 minerals, of 8 of which, viz., *Thulite*, *Crucilite*, *Kirwanite*, *Dysluite*, *Calcareo-sulphate of Barytes*, *Baryto-calcite*, *Sulphato-carbonate of Barytes*, *Bi-calcareo Carbonate of Barytes*, the chemical composition has never been previously published; for with the exception of *Thulite* their discovery is for the first time announced. The 3 remaining minerals are *Wollastonite*, *Gadolinite* and *Wolfram*. In *Gadolinite*, an earth has been detected which was not observed by the only analyst who had previously subjected it to examination, although his results are received by many with implicit reliance. In the same paper an elaborate examination of the salts of yttria and cerium is likewise detailed. Two new fossil crustacea are described in another original communication, while two papers are devoted to an interesting investigation into the subject of spirits, and two into that of sound.

2. Papers and extracts from Foreign Journals. These comprehend the subjects of Biography, Chemistry Mineralogy, Geology, Botany, Physics, Natural History, Physiology, Medicine, Statistics.

3. Analyses of Books. The object in this department

has been as it ought to be in every review, to present to the reader an outline of the work under consideration, more especially, of its plan and of any new facts which it may contain. This method has been extended to the Royal and Linnean Societies, which appears preferable to inserting papers at full length from the transactions of those Societies.

4. Under Scientific Intelligence are included such notices and answers to questions, as are too brief to form distinct papers. The reports of the Royal Institution lectures, which are generally of great interest, although presented under many disadvantages, will, it is hoped, be found upon the whole, to afford a pretty correct view of the facts and arguments brought forward. The meteorological table which falls under this head, is considered to be one of the most complete and correct ever published in this country.

The intention of the Editor, although he is sensible of many imperfections in it, has been to present his readers with a book of facts. Whether he has succeeded or not, he leaves others to determine. He cannot allow this opportunity to pass, however, without noticing the cheering encouragement which he has received from men of the highest distinction in Science; and of thanking all those who have hitherto supported him in his undertaking. He trusts to their future assistance, being fully confident, that the work will improve as it advances.

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PREFACE.

The utility of periodicals, in contributing to the rapid progress of Science and Literature, is sufficiently evinced in the simple fact, that their origin is but of recent date.

It is true, that some have endeavoured to discover their existence among the Romans, from a few obscure passages of Ovid and Tacitus. There can be little hesitation, however, in concluding, that the allusions of these authors refer not to publications analogous to our periodicals, but to incomplete or unfinished works, corresponding with the first editions of books in the present day.

The first periodical appears to have been published in the reign of Elizabeth in 1588, under the name of the "English Mercurie," an original number of which, is preserved in the British Museum. Until the reign of James II., periodicals were warmly encouraged, when bigotry and politics usurped their place.

Towards the end of the sixteenth, and during the course of the seventeenth centuries, numerous Scientific bodies were formed throughout Europe, for the purpose of cultivating Science, and of disseminating the results of their labours. Accordingly, the Royal Society of London, commenced the publication of its transactions in 1665, and its example was followed in 1699, by the Royal Academy of Sciences of Paris. The succeeding century, gave rise to many periodicals in Britain, which were signally effective, in spreading that taste for Science and Letters, which has so long distinguished this great country.

A few years have only elapsed, since not less than six Scientific Journals, were published in Great Britain; these have now dwindled into two, one of which, is published monthly in London, and the other quarterly, in Edinburgh.

The pages of the former, are chiefly devoted to original communications, while the latter, is principally conspicuous for its details of Natural History. There seems, therefore, to be required a separate periodical, which may afford intelligence not only of what is transacting at home, in reference to a more extended field of Science, but likewise of the researches of those, who are labouring in the same great cause abroad. With this object in view, the Records of General Science has been projected; and without detaining our readers, it is only necessary to state, that as utility is the great principle to be followed in conducting it, no pains shall be spared on the Editor's part, in endeavouring to collect all important new facts, which may be ascertained both at home and abroad—more especially, in the Sciences of Chemistry, Mineralogy, Geology, Natural History, Physics, and the Arts. The powerful assistance, of the Editor's relation, DR. THOMSON, of Glasgow, whose great knowledge and experience, in conducting the *Annals of Philosophy*, one of the most efficient Journals, of this, or any other country, under his management are well known, cannot fail to be considered as a high recommendation. And it is hoped, from the favourable manner in which the project has been received, by many distinguished cultivators of Science, that general support may be extended to the publication, in order that the Editor may be enabled to afford sufficient time for such an arduous undertaking.

RECORDS

OF

GENERAL SCIENCE.

JANUARY, 1835.

Article I.

On Calico-Printing. By Thomas Thomson, M. D., F. R. S., L. and E. &c., Regius Professor of Chemistry in the University of Glasgow.

Calico-printing is the art of applying one or more colours to particular parts of cloth, so as to represent leaves, flowers, &c., and the beauty depends partly on the elegance of the pattern, and partly upon the brilliancy and contrast of the colours. The process is not confined to *cotton cloth*, as the term *calico-printing* would lead us to suppose. It is applied also to linen, silk, and woollen cloth; but as the processes are in general the same, I shall satisfy myself with describing them as applied to cotton, because it is with them that I am best acquainted.

The general opinion is, that this ingenious art originated in India, and that it has been known in that country for a very long period. From a passage in Pliny, who probably composed his Natural History about the middle of the first century of the Christian Era, it is evident that calico-printing was understood and practised in Egypt in his time, but unknown in Italy.

" There exists in Egypt," says he, " a wonderful method of dyeing. The white cloth is stained in various places, not with dye-stuffs, but with substances which have the property of absorbing *(fixing)* colours. These applications are not visible upon the cloth; but, when the pieces are dipt into a hot caldron containing the dye, they are drawn out an instant after, dyed. The remarkable circumstance is, that though there be only one dye in the vat, yet different colours appear on the cloth; nor can the colours be again removed."* That this description of Pliny applies to calico-printing, will be evident to every person who will take the trouble to read the account of the processes which we are going to give.

The colours applied to calico in India, are beautiful and fast. The variety of their patterns, and the great number of colours which they understood how to fix on different parts of the cloth, gave to their printed calicoes a richness and a value of no ordinary kind. But, their processes are so tedious, and their machinery so clumsy, and they could be employed only where labour is so cheap as to be scarcely any object to the manufacturer. It is little more than a century and a half since calico-printing was transferred from India to Europe, and little more than a century since it began to be understood in Great Britain. The European nations who have made the greatest progress in it, are Switzerland, France, especially in Alsace, some parts of Germany, Belgium, and Great Britain.

In Europe, the art has been in some measure created anew. By the application of machinery, and by the light thrown on the processes by the rapid improvements in chemistry, the tedious methods of the Indians have been wonderfully simplified; while the processes are remarkable for the rapidity with which they are executed, and for the beauty and variety and fastness of the colours.

I propose in this paper to give a sketch of the different processes of calico-printing, such as they are at present practised by the most skillful printers in Lancashire, and in the neighbourhood of Glasgow.†

---

* Plinii Hist. Nat. lib. xxxv. c. 11.

† I think it right to state, that for all my knowledge of Calico-Printing, I am indebted to my friend, MR. WALTER CRUM, Calico-Printer, in the neighbourhood of Glasgow. With a liberality, for which I feel greatly indebted to him, he has explained his processes to me without mystery or reserve.

PRELIMINARY PROCESSES.

The cotton cloth, after being woven, is subjected to several preliminary processes, before it is fit for calico-printing. It will be sufficient merely to allude to them. They are *singeing* and *bleaching*. The singeing is intended to remove the fibres of cotton which protrude on the surface of the cloth. This is done, by passing the cloth rapidly over the surface of a red-hot iron cylinder, which burns off all the hairs, or protruding fibres of the cotton, without injuring the cloth. Of late years, an ingenious coal-gas apparatus has been substituted for the red-hot iron, both in Manchester and Glasgow.

The bleaching of cotton consists essentially of four different processes. 1. The cloth is boiled with lime and water; it is then washed clean. 2. It is steeped for some hours in a solution of chloride of lime, or *bleaching powder*, as it is usually called. From this steep also it is washed clean. 3. It is boiled in a solution of American potash. After the duty *was* taken off common salt, carbonate of soda (and consequently caustic soda) *became* so cheap, that it gradually took the place of pearl ashes.* 4. The cloth is now almost bleached; it requires only to be steeped in water holding in solution about four per cent. of sulphuric acid, to complete the process.

Cotton cloth at an average, takes about two days to bleach. But, when there happens to be occasion for greater dispatch, it is no uncommon thing to complete the bleaching and callendring in twenty-four hours.

PRINTING.

There are two modes of printing, namely, *block-printing*, and *cylinder-printing*. The former has been practised from time immemorial; the latter is a modern invention, and originated, probably, after the introduction of the art of printing into Great Britain.

The *block* is a piece of sycamore, (or, more commonly, a fir board, on which a piece of sycamore is glued) on which, the pattern intended to be printed on the cloth is cut. The parts which are to make the impression, are left prominent, while the rest of the block is cut away; just as is practised for wood engravings. When the pattern is too complicated, and the lines too fine to be cut in wood, they are made by means of small pieces of copper, drawn out into narrow ribbons of the requisite fineness; these are ingeniously driven into the block, and the intervals are filled up with felt. Great patience and ingenuity are displayed in making these blocks for use, and calico-printers are under the necessity of keeping a number of workmen, at high wages, for that express purpose.

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* An impure Soda ash is now very generally used by Bleachers. For, as every hundred pounds of crystallized carbonate of Soda contains 62½ of water, the expense of carriage is more than double, and although the form indicates in some measure the purity of this salt, every Bleacher knows how to estimate the value of the drier preparation.

The inventors and drawers of the patterns, constitute another class of ingenious artists, in the pay of the calico-printers at high wages.

The *cylinder* is a large cylinder of copper, about a yard in length, and four or five inches in diameter, upon which, the pattern to be printed on the cloth is engraved. This cylinder is made to revolve, and press against the cloth, taking up the mordants, or colours to be printed on the cloth as it revolves. By this ingenious contrivance, two or even three different colours, are printed on the cloth at once, and the printing proceeds, without interruption, till a whole piece, or indeed, any number of pieces attached to each other are printed.

Another method of printing is almost the same as copper-plate printing. The patterns is engraved upon a flat copper plate, a yard or more square. Upon this plate, the colour or mordant to be applied, is spread. It is then pulled. As it passes along, an elastic steel plate, called a *doctor*, takes off all the colour, except that which fills the engraving. Being pressed against the cloth in the act of pulling, it prints upon it either in mordants or colours, as may be the impression of the pattern.

Whether the printing is applied by the block, the cylinder, or the flat plate, the treatment of the goods is nearly the same.

Most commonly, the printing process is employed to fix the mordants upon the cloth, which is afterwards dyed in the usual way. Those parts only retain the colour which have imbibed the mordant, while the other parts of the cloth remain white. Sometimes acids, or other substances, are printed on cloth already dyed, to remove the colour from certain portions of it which are to be left white, or to receive some other colour.

Occasionally, substances are printed on cloth before it is dipt into the indigo vat, to prevent the blue colour from becoming fixed on those parts to which they are applied. Substances possessed of these properties are called *resist pastes*.

It is a very common practice to communicate mordants and colouring matters, to cloth at the same time.

We must give a sketch of the different substances thus applied, before proceeding to detail the different processes.

I. MORDANTS.

The term *mordant*, is applied by dyers to certain substances with which the cloth is impregnated before it is dyed, otherwise the colour would not fix, but would disappear on washing or exposure to the light. The name was given by the French dyers, (from the Latin word *mordere, to bite*,) from a notion entertained by them that the action of mordants was mechanical, that they were of a corrosive, or biting nature, and served merely to open the pores of the cloth, into which the colouring matter might insinuate itself. It is now understood that their action is chemical. They have an affinity to the cloth, which causes them to adhere to it; while the colouring matter has an affinity for, and adheres to the mordant.

The usual mordants employed by the calico-printer, are the three following:—

1. *Alumina*, or the *alum mordant*. This mordant is made by dissolving alum in water, and adding acetate of lime to the solution. The liquid has a specific gravity of 1·08, and contains about as much alum undecomposed, as the liquid can hold in solution. For particular purposes, calico-printers make a mordant by mixing three parts of acetate of lead with four of alum. This mordant consists of a mixture of acetate of alumina and alum; for, about a third part of the alum remains undecomposed.

When cloth is impregnated with this mordant, such is the affinity of the alumina for the cloth, that the acetate of alumina, and even a portion of the alum, are decomposed, and the particles of alumina adhere to the fibres of the cloth so firmly that they cannot be removed by washing.

In order to determine the quantity of alumina fixed on on the cloth by the aluming process, I got a quantity of the cotton cloth that was to be dyed Turkey-red; 1000 grains of this cloth were burnt, and the ashes being reserved, and subjected to a chemical analysis, were found to contain 0·4 grain of alumina; 1000 grains of the same cloth after being dyed Turkey-red, and of course, impregnated with the alum mordant, were treated in the same way. The alumina obtained amounted to 8 grains. The length of a piece of this cloth, weighing 1000 grains, was 1 yard 5⅔ inches, and its breadth 33 inches. Thus, a piece of cloth, amounting to 1386 square inches, or rather, 2772 square inches, (as both sides of the cloth had been equally subjected to an aluming process) had combined with 7·6 grains of alumina; or every square inch of the cloth had combined with 0·0027 grains ($\frac{1}{370}$th of a grain nearly) of alumina.

1000 grains of the same cloth were dyed the palest shade of Turkey-red usually given to cloth. When burnt, the ashes were found to contain 0·8 grain of alumina. Subtracting the 0·4 grain of alumina belonging to the cotton fibres, there remains 0·4 grain for the quantity communicated during the aluming process. In this case, every square inch of surface of the cloth had combined with 0·00012 grain of alumina, or less than $\frac{1}{8000}$th of a grain. Yet this quantity of alumina small as it is, was essential to the permanence of the dye. For, when unalumed cloth was dyed with madder, the colour was easily washed out with water.

When cloth to be dyed red is impregnated with this mordant, it is not thickened. When applied only to particular parts of the cloth, by the block or cylinder, it is thickened with flour, or calcined starch, or gum senegal, according to the nature of the style of work.

2. *Oxide of tin.* Perchloride of tin is very much used as a mordant. The colouring matter is previously mixed with it, and both are applied at once. Such applications

are usually called *chemical colours.*[*] The mixture is allowed to dry on the cloth, which is then merely washed with water. When colours are applied in this way they are easily altered by soap, exposure to the light, &c. Hence, in common language, a *chemical colour* means a fugitive colour. The colours produced in this way, are *pink* from Brazil wood, peach wood, and cochineal; *purple* from logwood, and *yellow* from Persian berries.

Perchloride of tin is much used in another common process of calico-printing, known technically, by the apellation of *steam colours.* It is decomposed and converted into *stannate of potash.* The whole piece of cloth is immersed in the liquid containing the stannate of potash, and dried. The peroxide of tin is then deposited on the cloth, by immersing the piece in a solution of sal ammoniac, or sulphate of magnesia; but most commonly, in a very weak solution of sulphuric acid. The different colouring matters, previously thickened with starch, are then printed on the cloth, and the whole subjected to the action of steam. By the joint action of moisture and heat, a combination takes place between the colouring matter and the oxide, which is thus rendered insoluble. And no considerable quantity of water is ever present to carry off the colouring matter, before it has combined with the mordant.

3. *Peroxide of iron.*—This metallic oxide is much used as a mordant. It is employed in the state of acetated protoxide of iron, formed by dissolving iron in pyrolignic acid. Within a few days after it has been applied to the cloth, especially if exposed to a moist atmosphere, it loses its acid, and the iron becomes peroxidized.

Acetate of iron, of the specific gravity 1·05 gives a black, with madder. Various shades of *purple* are obtained by adding different portions of the mordant and dye-stuffs. Different shades of *red,* from brown, red, to pink, are obtained in the same way, substituting the alum mordant of various strengths for the iron. *Chocolates* are got by mixing the aluminous and iron mordants, and then dyeing with madder.

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[*] A very general error prevails with regard to Chemical colours, that it is the mode of applying them which renders them fugitive. It is, because Chemical colours are made with changeable materials, that they are more easily acted on than madder colours. Brazil pink for instance, is equally acted upon by light and soap when dyed.

Indigo, oxide of manganese, catechu, &c. are colours per se, and therefore, require no mordant.

II. DISCHARGERS OF COLOURS.

Most colours are fixed to the cloth by mordants; or if they be metallic oxides, they retain their affinity only at a particular state of oxidizement.* Thus madder is fixed by alumina, and cochineal by means of oxide of tin. Manganese adheres to the cloth only when in the state of sesquioxide, and is washed away by water the moment it is converted into protoxide. Hence, when the printers wish to discharge a colour from cloth, they employ something that will dissolve the mordant, or which will deoxidize the oxide, or colouring matter, if no mordant be present. The *dischargers* are either acids, or substances having a strong affinity for oxygen; the former being employed to dissolve the mordants, and the latter to deoxidize the oxides. The chief of these are the following:—

1. *Citric acid* is much used to dissolve alumina, and peroxide of iron, and thus to prevent the formation of colour on particular parts of the cloth, by removal of the mordant, which would otherwise produce them. It is obtained by evaporating lemon juice, and thickening it with gum-senegal for the cylinder, or with gum and pipe-clay for the block. Its action is occasionally assisted by bisulphate of potash, or sulphuric acid.

Sometimes the citric acid is first printed on white cloth, and afterwards the aluminous or iron mordant is applied slightly thickened. It is dried immediately to prevent the swelling of the acid figures. At other times, the mordants are first applied, and the acids printed over them.

In both cases, the goods are afterwards passed through hot water, containing cow dung, and well washed before they are dried. This removes the mordants from all those parts to which the acid has been applied, which of course, remains white after the cloth is dyed.

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* Almost every thing which can be applied to cloth, in a state of solution, and which becomes afterwards insoluble in water, either by precipitation, or spontaneous decomposition, sticks to the cloth when it is washed. Water, therefore, does not remove protoxide of Manganese, and the protochloride of tin alluded to at the conclusion of this section, as a means of removing the sesquioxide or peroxide of Manganese, not only takes away their oxygen, but converts them into a soluble chloride.

2. *Tartaric acid* thickened with gum, is applied by the block, or cylinder, to cloth previously dyed Turkey-red. It is then passed through an aqueous solution of chloride of lime. The acid disengages chlorine from the chloride, which of course, destroys the colour of those parts to which it had been applied, while all the other parts of the cloth retain their red colour. When oxide of lead is deposited on the cloth, along with the acid, and the cloth after passing through the aqueous solution of the bleaching-powder, is passed through an aqueous solution of bichromate of potash. The parts that would have remained white, are converted into a fine yellow. This beautiful process is not confined to Turkey-red.

3. *Protochloride of iron* is used to discharge the manganese brown, and substitute a buff. This it does, by depriving the manganese of oxygen, and thus rendering it soluble: (the manganese is made soluble by conversion into chloride of manganese) while the protochloride of iron, being converted into perchloride, deposites peroxide of iron on the cloth, which produces the characteristic *buff* or *orange* colours of that oxide.

Sulphate of iron is used in a variety of ways. It deoxidizes the indigo in the indigo vat, and renders it soluble in lime-water. It produces *gold*, *buff*, *&c.* colours, and makes a good chemical black with logwood.

4. *Protochloride of tin*, when applied to cloth dyed brown by the sesquioxide of manganese, immediately deoxidizes it, discharges the colour, and leaves the part white. If it be mixed with Brazil wood, or cochineal, it discharges the manganese, but leaves a pink. When mixed with logwood, it leaves a *purple;* and when with Prussian blue, a *blue.*

To produce a yellow upon manganese brown, chloride of tin is mixed with sulphate of lead. This mixture thickened with roasted starch, is printed on the manganese brown. As soon as it is dry, the manganese being reduced to the state of chloride may be washed off; but the sulphate of lead adheres to the cloth, in consequence of an affinity between them. The cloth being now limed, and passed through a solution of bichromate of potash, those parts which contain the oxide of lead are dyed a beautiful yellow.

Chloride of tin is capable also of removing peroxide of iron from cloth, by reducing it to chloride, as it does the sesquioxide of manganese. For this purpose it is sometimes printed on a deep colour, composed of peroxide of iron and quercitron yellow. The protochloride of iron is formed and washed away, while the oxide of tin remaining, constitutes a mordant for the quercitron. Thus the parts to which the tin was applied become yellow.

Protochloride of tin is also employed occasionally, to discharge the orange, consisting of dichromate of lead from the cloth. This it does by reducing the chromic acid to protoxide. But as the green oxide of chromium still continues fixed, the discharged parts do not assume a good white colour. But this does not much affect the blue and purple colours substituted for the orange, by mixing the tin with Prussian-blue, or with logwood.

When protochloride of tin is decomposed by carbonate of soda, protoxide of tin is obtained. This protoxide is used along with potash, to render indigo soluble. The protoxide deoxidizes the indigo, and the potash dissolves the yellow base. It is then applied to the cloth in the way that will be explained afterwards.

III. RESIST PASTES.

These are substances which have the property of restoring the blue colour to dissolved indigo, and thus, of preventing it from becoming fixed on those parts to which the resist-pastes have been applied. Any substance which has the property of readily parting with oxygen, answers this purpose. *Sulphate of copper*, or any salt containing black oxide of copper, when put into the indigo vat, instantly revives the indigo, by communicating oxygen to it. The hydrated black oxide of copper has the same effect, and so have the sesquioxide and deutoxide of manganese.

The calico-printer's indigo vat is a very deep large vessel filled with water, into which indigo, sulphate of iron, and an excess of lime are put. The lime decomposes the sulphate of iron, and the disengaged protoxide of iron coming in contact with the indigo at the bottom of the vat, deprives it of an atom of oxygen, and thus renders it capable of combining with the lime, and of forming a compound which dissolves in water, and forms a yellow liquid. Where this solution is in contact with the atmosphere, the indigo is revived, assumes its blue colour, and loses its solubility. Hence, the blue scum which always covers the surface. But this scum, in some measure, protects the rest of the vat. When cloth is dipt into this vat it comes out yellow. But from the exposure, the indigo gradually absorbs oxygen and becomes blue. The cloth at first, from the mixture of the blue and yellow, has a green colour, which slowly deepens into blue. But if, to any parts of the cloth before it be dipped into the vat, something has been applied which has the property of giving out oxygen to the indigo; all the indigo which would be imbibed by these parts is revived, before it comes in actual contact with the cloth; and, in the revived state, it is incapable of combining chemically with the cloth, but may be easily washed off. Hence, the parts covered by *resist-pastes* remain white.

The following are the principal resist-pastes used by calico-printers:

1. *Blue paste, or vitriol paste* consists of a mixture of sulphate and acetate of copper, and the solution is thickened with gum-senegal and pipe-clay for the block, and with flour, for the cylinder. When the cloth on which this paste has been printed is dipt into the indigo vat, the indigo is revived before it has time to reach the surface of the cloth. After dyeing, the piece is passed through weak sulphuric acid, to remove the oxide of copper which has been precipitated on it.

2. *Mild paste* consists of sulphate of zinc, gum, and pipe-clay. It is used along with colours which copper would injure, or which would be destroyed by immersion in sulphuric acid. It resists a pale blue, and the removal of the oxide of zinc by an acid, is not necessary, as it is when copper has been employed

Sulphate of zinc, as well as all the other metallic salts and all the acids, precipitates indigo from its solution in lime. It does not revive the indigo like the salts of copper; but when the base of indigo is precipitated, it is not so readily fixed as when in a state of solution. The oxide of zinc with the gum and pipe-clay, acts mechanically in keeping it at a distance.

3. *Red paste* consists of the alum mordant already described, mixed with acetate of copper, gum, and pipe-clay. It resists pale blues, and the alumina remains upon the white portions of the cloth, to be afterwards dyed *red*, with madder or *yellow* by quercitron bark.

4. *Neutral paste* is a name given by printers, to a compound of lime juice, sulphate of copper, gum, and pipe-clay. It resists during a short dip in the blue vat; and the lime juice gives it the property of remaining white when the piece is dyed in madder, even when the preceding *red paste* goes over it. This acid also prevents the lime of the blue vat from precipitating copper upon the cloth, which would cause the parts to assume a deep brown tinge when dipt into the madder vessel.

5. *Chrome yellow resist paste* consists of a mixture of a salt of copper, to resist the blue vat with a salt of lead, to produce a yellow with bichromate of potash, after having been dyed in the blue vat.

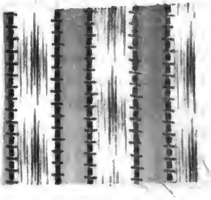
The preceding observations were necessary, to give the reader an idea of the various processes, followed by the calico-printers, and with the rationale of them. I shall now proceed to explain the different colours. And both the simplest and most intelligible method of proceeding seems to be, to place pieces of printed calico before the eyes of the reader, and describe the way in which the colours on them have been produced. We shall begin with the simplest colours, and proceed gradually to more complex ones.

1. *Madder Red.*—The alum mordant described above, is made into a paste, and printed on the cloth by the cylinder. After being dried and exposed in a warm room, till the alumina has had time to leave the acid with which it was united, and combine with the cloth, it is passed through a hot mixture of cow's dung and water. It is then washed in cold water, and agitated a second time in the same hot mixture. After being thus freed from all soluble or loose matter, it is dyed in madder. This process consists in the exposure of the

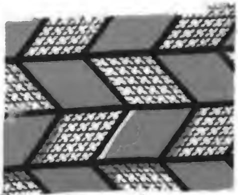
cloth to the action of madder, suspended in water. In consequence of the very sparing solubility of the colouring matter of that root, and the difficulty of applying it equally to all parts of the cloth, the process requires to be conducted slowly, and the heat to be very gradually raised. The purest portion of the colouring matter being first given out by the madder, the degree of heat is varied, according to the fineness of the colour we desire to obtain.

After dyeing, those parts of the cloth intended to be white, are always, more or less, tinged with the madder, and much pains are necessary to restore their purity. For this purpose, boiling with bran, or with soap, exposure to light upon the grass, clearing with chloride of lime, or other substances, which have the property of dissolving or destroying this colouring matter, with repeated washings in cold water, are all resorted to according to circumstances. And several of these operations have the additional effect of brightening the red, by abstracting a brownish matter, which always combines with the alumina, at the same time with the red colouring matter.

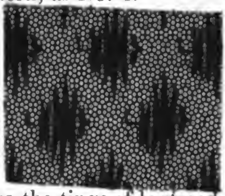
2. *Madder Purple.*—The iron mordant thickened in the same way as the alum mordant, is similarly applied. The cloth is then exposed to the air for a few days, and the iron fixes itself on the cloth in proportion as it becomes peroxidized. The piece is then cleaned and washed as described in the last process, dyed in madder, and cleared in the same way as in the red just described. The depth of the purple depends upon the strength of the iron mordant. If its specific gravity be as high as 1·04, it forms a black, as appears in the three succeeding specimens.



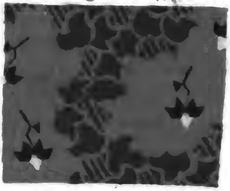
3. This piece shows two different shades of purple, or rather black and purple along with red, all dyed at once. The black and purple are printed together by the cylinder machine, with two copper rollers, and the purple is printed afterwards by the block.



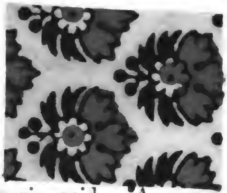
4. *Cochineal Pink.*—After the black in this pattern has been produced in the way already detailed, it receives an alum mordant on those parts which are intended to become pink. It is then cleansed and dyed in cochineal, in a similar way as when cloth is dyed with madder. The cochineal does not tinge the ground as madder does; and therefore, does not require, nor is it of sufficient permanence to bear the same clearing operations. So much colouring matter does the cochineal insect contain, that one ounce is sufficient to dye fifteen or twenty yards of such a pattern, as No. 4.



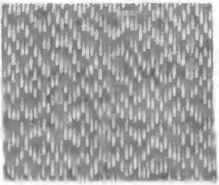
5. *Logwood Black.*—The same alum mordant which forms a red with madder, becomes black when dyed with logwood. The iron mordant has the same property; but it forms a brownish, and less pleasing colour. Rinsing the piece of goods in hot bran and water, is sufficient to remove the tinge of logwood from the white ground.



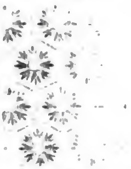
6. The two shades of colour in No. 6, are obtained from mixed alum and iron mordants, dyed in a mixture of madder and quercitron bark. The mode of producing the black and white figures on it, will be explained afterwards.



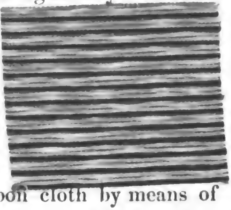
7. *Prussian Blue*—The iron mordant is applied, and the cloth cleansed in the way already described. It is converted into prussian blue of various hues, by immersion in cold prussic acid. This acid is liberated from a weak solution of prussiate of potash, by an equivalent of sulphuric acid. A more convenient process for this colour, is now employed, and it will be explained, when we come to speak of steam colours.



8. *Buff from Iron.*—This pleasing colour is merely the peroxide of iron. A mixture of sulphate of iron and acetate of lead is printed on the cloth, constituting in fact, sulphate and acetate of iron together. After exposure to the air for a considerable time, to produce as large a deposit as possible upon the cloth, the iron is farther precipitated by immersing the piece in thick lime water, or in a mixture of caustic potash and lime. A portion of black oxide is thus thrown down along with the red, which speedily changes in the fresh water and air to which it is afterwards exposed.



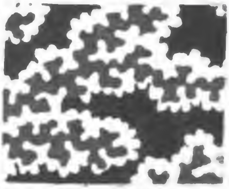
9. *Manganese Bronze.*—A solution of sulphate of manganese is printed on the cloth by the copper roller. When dry, the piece is passed through a strong caustic alkali, and then allowed to fall into a vessel containing chloride of lime. This converts the manganese into sesquioxide, which has a strong affinity for cotton.



10. *China Blue.*—Indigo may be fixed upon cotton in a variety of ways. By heating it with orpiment and caustic potash, it is deoxidized and dissolved. If gum-senegal or roasted starch be not dissolved in the solution, it forms what is called *pencil blue,* which may be printed upon cloth by means of the copper roller, or by the block from a sieve of a peculiar kind. Applied in either of these ways, the indigo soon recovers its blue colour, and being no longer soluble, it remains upon the cloth, while water removes the substances with which it was mixed.

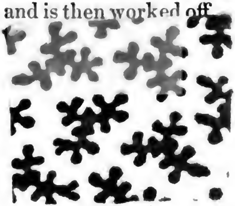
By another process, indigo in the blue state is mixed with orpiment in a solution of sulphate of iron, and deoxidized after being printed on the cloth, by alternate immersions in lime and copperas. It is known that indigo in the deoxidized or white state, is soluble in alkalies, forming a yellow coloured solution. This solution deposits its deoxidized indigo on the cloth by mere contact. In this way the indigo which is at first loosely laid upon the fibres, and easily removeable by washing, is slowly combined with them, and thus becomes fixed on the cloth. A large quantity of iron is necessarily attached to the cloth during this process, and a continued action of sulphuric acid is necessary for its removal.

A third process consists in dissolving powdered indigo in a hot solution of potash, and stannite of potash, or by boiling it in potash or soda, along with metallic tin. It is then precipitated in a white state by muriatic acid, and the precipitate being thickened and mixed with fresh chloride of tin, is printed on the cloth. When dry, the piece is immersed in a solution of carbonate of soda. The indigo becomes yellow by combining with the soda, and in this soluble condition, attaches itself permanently to the cloth. It soon afterwards becomes blue, by the absorption of oxygen from the atmosphere.



11. *Catechu Brown.*—This important dye-stuff, formerly known by the name of *terra japonica*, is procured by boiling the brown heart wood of the acacia catechu, or khair-tree. It is obtained by simply boiling the chips in water, until the inspissated juice has acquired a proper consistency. The liquor is then strained, and soon coagulates into a mass. It comes to this country both from Bombay and Bengal. It consists chiefly of tannin, but contains also a little alumina, which may perhaps assist in fixing the colour on the cloth.

The catechu is dissolved in acetic acid; a solution of copper and sal ammoniac is added to it, and the whole printed on the cloth. It is allowed to stand a few days, during which the colour deepens very much, and is then worked off.



Chrome Orange.—The dichromate of lead is precipitated upon the surface of cotton cloth, by printing on it a solution of lead, and then immersing the cloth in a hot solution of a chromic salt of potash, or of lime, containing a slight excess of base; or, it is sometimes obtained from the yellow chromate of lead, produced from the bichromate of potash, by abstracting a portion of its acid in hot lime-water.

To be continued.

ARTICLE II.

A Journey in Spain. By M. F. LE PLAY. (Abridged from the *Annals des Mines*, tom. v.)

SPAIN presents numerous points of interest to the man of science, but in proportion as this fact has been gradually developing, so has the political state of events in that unfortunate land increased the difficulties of investigation. It appears, however, unquestionable, that the obstacles to travelling, at least on the thoroughfares of Spain, (as from Bayonne to Cadiz, where the route is as fine as any on the continent) have been greatly exaggerated.

Spain was anciently celebrated for its mineral riches. Pliny speaks of lead, tin, iron, copper, silver, gold, and mercurial mines, which were all in activity, but were relinquished towards the termination of the Empire of Rome. The Moors explored numerous mines, in the east of the Peninsula, but on their expulsion these sources of wealth were entirely abandoned. Spain still bears on its surface permanent marks of the energy with which the improvements introduced from the east were overturned. When the traveller demands the cause of the innumerable ruins and abandoned mines which cannot fail to attract his attention, he learns that these desolating catastrophies occurred at the expulsion of the Moors. As a finishing blow to Spanish industry, the Kings of Spain in the fifteenth century,issued an interdict against working the Peninsular mines for the purpose of encouraging those of America. The mercurial mines of Almada alone were in operation; because, their product was necessary for the extraction of the precious metals in New Spain. The quantity sent from thence annually, amounted to 6000 quintals. Towards the middle of last century the mine of Huancavelika in Peru, which had previously supplied the greatest part of the mercury for the precious mines, became depreciated in the quality of its product, and thus a new stimulus was afforded to those of Almeyda. But these intervals of prosperity seem to have been the mere flickerings of the flame before it expired, for war raged in the Peninsula, America assumed its independence, and the industry of Spain was almost extinguished. In this condition Spain remained till 1820, when political events changed in some measure the state of affairs.

The inhabitants of the mountainous country of Alpujarras, who had lived, from the time of the departure of the Moors, in a wretched and immoral state, roused themselves from their lethargy, on the intelligence of the destruction of the odious monopoly, and began to work their lead mines. In the course of a few months these poor men were comparitively wealthy, for by 1826, no less than 3500 mines were in activity in the Sierras of Gador and Lujar; and in 1833, M. Play ascertained that 4000 shafts had been opened in the Sierra of Gador alone. Before 1820, the royal works which had the sole power of smelting ores, produced annually only thirty or forty thousand quintals of lead. In 1823, however, the product was increased to 500,000, and in 1827, to 800,000 quintals.

This prodigious increase in industry created a great sensation in Spain; and all classes of society, directing their attention to the mines, conceived that they had only to turn up the soil, in order to acquire endless treasures.

The government, at the same time, gave its countenance to the labours of the people, by forming two mining schools, the one at Madrid, the other at Almeyda, and by sending several young men to study the art of mining at Freiburg. M. Vallejo, who had been banished during the political disturbances, and had improved his time by studying at Paris, returned to his native country, and is at present engaged with a geological description of Spain. Erlorza also, an artillery officer, having visited the iron works of England, Belgium, Hartz, Piemont, and France, has introduced the most approved smelting system of these countries, into the neighbourhood of Marbella and Pedroso in Andalusia. By his advice the iron works of Gallicia have been altered; and speedily his improvements will extend over Spain. During the short period described, the product of the mercurial mines of Almeyda increased; the ancient copper mines of Rio Tinto long neglected, were now worked with energy; the calamine mines of Alcaraz, in the eastern part of La Mancha, are successfully explored at present, lead is raised in considerable quantities at Linares in Jaen, and at Falsete in Catalonia. In the neighbourhood of Oviedo, rich mines of coal which occur there, supply, although the communication is bad, the establishments of Andalusia. Coal mines have also been opened by a company near the river Aviles; and in another part of Spain, the small coal bason of Villa Mieva del Rio, situated eight leagues above Seville, is worked with increasing activity, and supplies the steam boats, which make the voyage from Seville to Cadiz in twelve hours.

M. Le Play travelled by Tolosa, Miranda, through the Sommo Sierra to Madrid, by Cabrera and Alcovendas, and made the subsequent observations.

At Vittoria the powerful causes which have given to the Pyrenees their form, is strongly observed; and near this place also occurs the border of the sea, in which are deposited tertiary formations. This border, as well as the two stages of the cretaceous formation, is parallel to the direction of the two principal edges of the Pyrenees, running nearly from west 18° N., to E. 18° S. Hence, Biscay, Navarre, and the North of Arragon, present a simple geological structure; and the road from Bayonne, nearly perpendicular to the direction of the chain, is extremely favourable for studying the two bands of chalk, below which the Jura formation shews itself occasionally. The plains of Old and New Castile appear to have been recently elevated, and subsequent to the deposition of the most modern tertiary formations, for Le Play has observed that the surface was formed exclusively of tertiary masses of calcareous marls, gypsum and compact limestone; and below these stratified rocks, thick beds of sand and rounded pebbles occur, which possess a considerable depth in the plains which cross the road from Madrid to Estramadura, between the Tagus and the boundaries of Old and New Castile. Le Play considers this formation as contemporaneous with the formation produced by the disruption of the principal Alpine chain.

The tertiary layers are observed thick at Briviesca in Old Castile, and in the undulating plain to the south of Madrid, and at Cuesta de la Reyna, on the sides of the great cut which exists in this plain near Aranjuez, where the Tagus and Jarama unite. The sea in which these tertiary formations are deposited appears to have extended in the direction from Bayonne to Cadiz over Aragon, and to have communicated with the Mediterranean by an opening across the mountains of Valencia and Catalonia, which was probably the ancient strait of Gibraltar. The southern part of Spain seems to have been only recently disjoined from Africa. The epoch of the elevation of Central Spain is referred by Le Play to that of the principal chain of the Alps; the nature of the soil, the directions of the chains of mountains, the course of the rivers, the stratification of the rocks, being sufficient traces of a revolution contemporaneous with the appearance of the ophites.

The Sommo Sierra chain, whose summits are clad with snow during the whole year, is almost entirely composed of granite, which has broken a thick layer of gneiss and mica slate, at some remote period.

No trees adorn the desolate plain which extends from Sommo Sierra to Madrid; and no symptom of an approaching capital is observed until the traveller fairly reaches Madrid, which forms a perfect oasis. Over the small stream Manzanares, an elegant bridge conducts to the capital of Spain. Here the only object of interest is a cabinet of natural history, derived from Spain and its colonies, but arranged according to the systems extant in the reign of Charles III.

Within a few years Government have instituted a school of mines, which although well supported in some of its departments, with the exception of a considerable library, collections of minerals and apparatus, is defective in the necessary means for instructing students.

The great plains which extend from the Tagus to the mountains of Guadarrama, consist of clay and sand. The greatest part is uncultivated; but the abundant natural harvest of lavender and leguminous plants, is a sufficient proof of the fertility of the soil. At Talavera, however, the soil is richly cultivated, and the numerous aqueducts which rise above the olive groves, are a lasting memorial of the exertions of the Arabians in the advancement of agriculture.

Travelling in Estramadura is dangerous, for even the husbandman is compelled to arm himself during his labours in the field. From Almaraz to Trujillo, the traveller passes through forests of oak, and gradually descends to the latter city, the birth-place of Pizarro, which is situated on the sides of a granite hill. The granite of Trujillo is separated from that of Sierra de Guadelupe, by a band of transition slate. Near Logrosau, small veins of quartz and phosphate of lime occur, which have been magnified into mountains of phosphate of lime, by some credulous individuals.

To Almeyda from thence, the soil consists of solid pebbles, and on the South-East, at the Guadiana, a transition plain exists. Almeyda in some points resembles the Hartz, but especially in the manners of the people, which have gradually at different periods been introduced from Germany. The mines of Almeyda are very ancient; for according to Pliny, the Greeks extracted vermillion from them 700 years before our era. The Romans drew annually from them, 100,000 livres of cinnabar.

The present flourishing state of these mines is indicated by the fact, that 22,000 quintals of mercury are annually furnished by them, and that 700 men are employed in mining, 200 in extracting the ore, besides a great number of muleteers, who convey the mercury to Seville. The veins are so rich, that although the mines have been worked for ages, the mining has only been carried the depth of 300 varas, or 300 metres. The whole vein is extracted, and when distilled yields 10 per cent. of mercury. The same mineral is found in a number of points in the direction of a band, which extends to Almadenejos, where the metal is extracted from a black slate, containing very little cinnabar. The minerals are treated at Almeyda in eight furnaces called Buytrones, and at Almadenejos in five.

The mercury has a fatal action on the industrious miners, and with infinite regret the traveller beholds men in the prime and vigour of their days, presenting a deadly aspect. M. Play passes a high eulogium upon the manners of the miners, whose characters in every respect are of the highest order.

The Sierra Morena form a chain of round topped mountains, appearing naked and barren when seen from afar, but in reality covered with a diminutive forest of strawberry trees, (Arbutus Unedo) pistachio, and different species of cisti.

Near Cordova, at the foot of the chain, the waterworm stone formation is observed, where it covers a shell limestone containing fossils identical with those of Corsica.

The whole of the low plain of Andalusia appears to consist of a formation analogous with that of Castile; but as the characters of the formation are different in a mineralogical point of view, the sea in which it was deposited, must have been separated by the promontory of the Sierra Morena. The central part of Estramadura is covered with a rich herbage, which affords abundant pasturage to the Merino sheep.

At Badajoz, a small chain of tertiary hills crosses the Guadiana; and dislocated shell-limestone passing to dolomite, is in intimate connection with the infiltrations of crystalline rocks, of diallage and hypersthene. The latter are also met with at Almeyda Cazallase. The tertiary sand extends parallel to the frontiers of Portugal, while the chain of Alburquerque consists of slate and quartz, affording a curious succession toward Caceres, from granite to slate, and transition greywacke. The slate and greywacke are covered with beautiful forests of green oaks and cork trees, but the granite is destitute of vegetation. The chain of Montanchès consists of granite. The Sierra d'Orellana, a transition ridge contains hematite near Oxellanita. To Llerena, the rocks are slate and greywacke, but here, limestone occurs with beds of galena, carbonates of copper, &c., and extends along the Rio Biar. Near Fuente del Arco a small bason of coal occurs, with nearly horizontal beds. The sides of the hills here are covered with beautiful olive plantations, and the soil though little cultivated, is of the richest and most promising nature.

In the beginning of the seventeenth century, the silver mines of Guadalcanal near Llerena, were worked by two Germans, brothers, of the name of Fuggars, who amassed great wealth, and gave origin to the proverb still current in

Spain, *as rich as Fucares.* The mineral is contained in calcareous veins, in small quantity, but not in the sulphate of barytes, which occurs also in the neighbourhood.

Recently a company have re-opened these mines, but it is feared, will be obliged to relinquish them, after an expenditure of above 4000*l.* At Cazalla, silver mines were formerly worked, but are now abandoned. African vegetation is here observed in the form of the Agave Americana and Chamœras humilis. The Sierra Morena, to the north-east of Seville, contain a great variety of stratified rocks belonging to the transition formation, but are principally formed of granite and mica slate. At the foot of these mountains is the coal bason of Villa Nueva del Rio, which is bounded on the south by the plain of the Guadalquiver. This coal is worked by a company of Seville, and the peroxide of iron is smelted by another company at Pedroso, the product being exported into France in the form of bars.

Seville is one of the most prosperous towns in Spain, which it owes to its situation on the fine navigable Guadalquiver, and to its admirable climate,—for here oranges and dates grow luxuriantly, and plants of the warmest climates are matured in the botanic garden. Seville possesses an excellent cannon foundery, where the best pieces in Europe are cast.

On the Rio Tinto we meet with copper mines which were worked by the Romans, Arabians, and Moors, and were re-opened in the beginning of the eighteenth century, but it was only in 1787, that the present method of extracting the copper by cementation with iron from the water flowing from the mine was adopted. The iron employed for this purpose is derived from Pedroso, and the quantity of copper raised amounts to 1800 quintals. The country by the mouth of the Guadalquiver to Cadiz and Tarifa, consists of tertiary formations; and at Conil, clay marl occurs, impregnated with abundance of sulphur crystals.

The coast, from Tarifa to Almeria, is extremely uniform in its configuration, presenting a ridge of lofty mountains, rising up from the sea, formed of clayslate and limestone, with occasional masses of serpentine, dolomite, calcareous and dolomitic brecchia.

Protoxide of iron is found half a league from Marbella, at a considerable height on the south of Sierra de Ronda, and is smelted in the works of Rio Verde, either by the charcoal furnace or by the reverberatory furnace, with coal which is brought by the French ships from Asturia.

The hills in the vicinity of Grenada, consist to a considerable height of sand, and at Vega appear to cover the marls and gypsum of the lacustrine bason of Alhama. On the heights of Alhambra and Generaliffe, the debris of grenatiferous mica slate, as upon the summits of the Sierra, are observed in abundance. The Sierra Navada owes its origin to several successive disturbances, but the presence of sand at such an elevation above the plain of Grenada, leaves no doubt of the very recent occurrence of the last of these movements. If the sands of Generaliffe be contemporaneous with those of Castile, and be superior to the marl and gypsum, then it is probable that their elevation was accomplished simultaneously with the origin of the Eastern Alps. The direction of the summits of the Sierra Nevada, is from E. 20° N. to W. 20° S. No granite could be detected on their summits; but mica slate was noticed. It is probable that an attentive examination of this ridge may throw some light upon the theory of Beaumont. The country between the Sierra Navada and the sea consists of elevated chains, whose summits are covered with mica slate, filled with garnets; but the central part of these mountains is principally composed of clay slate, associated frequently with brecchia, united to black saccharoid limestone, dolomite, fragments of limestone, quartz, and talc-slate, which are found at a great elevation.

It is in the ridges of Alpujarras nearest the sea, in the Sierra de Lujar and Gador, that the lead mines occur which have been already mentioned. The Sierra de Gador is chiefly composed of the same compact limestone which associated with the clay-slate, and intersected frequently by masses of gypsum, serpentine, &c., form a great portion of the chain which extends from Almeria to the Straits of Gibraltar. The product of the mines is so far from decreasing, that in consequence of the depreciation of the price of lead, and the abundance of the ore, it was determined to cease from working during six months of the year, which raised the price of the metal. The Galena, from the Sierra de Gador, is used in the state in which it comes from the mines, in thirty-one different works, comprising sixty-nine reverberatory furnaces, and fifty-eight common furnaces; the minerals affording, by the former method, sixty-six per cent. The mountainous nature of the country renders the formation of good roads impracticable, and hence, the product of the mines is carried, by numerous troops of asses and mules, first to the works, and then, after reduction, to the ports of Adra, Roquetas, and Almeria.

ARTICLE III.

On Respiration. By THOMAS THOMSON, M. D., F. R. S., L. and E., &c. Regius Professor of Chemistry in the University of Glasgow.

WHEN the experiments on respiration were made by Lavoisier, Goodwin, Menzies, Davy, &c., towards the end of the last century, it seems to have been the generally received opinion, that every individual by inspiring the air into his lungs, produces the very same change upon it. At least, the conclusions respecting respiration to be met with in Physiological and Chemical books, depend for their accuracy, upon this assumption. Nothing, however, can be farther from the truth. The chemical changes produced in air by respiration, vary in their extent, not only in different individuals, but even in the same individual at different times; and that to such an extent, that if we analyze air thrown out of the lungs at different times, we find the quantity of carbonic acid, sometimes not to exceed two per cent, and at other times to amount to more than seven per cent. Dr. A. Fyfe and Dr. Prout have shown many years ago, that an alteration is produced in the quantity of carbonic acid in the air expired, by the mode of living of the individual: that when the constitution is affected by mercury, the proportion of that gas in the air expired is diminished, and that it is diminished also by nitric acid, by spirits, and by a vegetable diet. But I have found that the most unexpected alterations are observable in the same individual, though he be in perfect health, and though he make no sensible alteration in his mode of living.

During the course of the month of May, 1832, I analyzed air from my own lungs on ten consecutive days, between eleven and twelve o'clock each day. Before stating the results, it may be proper to mention the method of analysis employed. I procured a glass tube, capable of holding about three cubic inches of air, and about half an inch in diameter. It was shut at one end and open at the other. This tube being filled with mercury, and placed inverted on a mercurial trough, I introduced into it about two and a-half cubic inches of air from my lungs, taking care, in the first place, by making half an expiration through a narrow glass tube, to expel all the common air from the trachea and mouth, and also from the tube, by which it was conveyed to the eudiometer. The surface of the mercury in the tube was then marked by tying round it a sewing thread, and the whole was left till the air ceased to contract. Then a quantity of moderately strong potash ley was introduced, and the whole was left untouched for twenty-four hours. The diminution of bulk of the air was then carefully marked, by tying a sewing thread round the tube at the new surface of the mercury. I then filled the tube with mercury, up to each of the places marked by the sewing threads, and weighed each portion of mercury. The difference between the two weights, gave the diminution of bulk sustained by the air, by the absorption of its carbonic acid. I then calculated, what the bulk of the air and of the carbonic acid gas absorbed would have been, at the mean pressure and temperature; making allowance for any change in the height of the barometer and thermometer, which took place during the interval. I ought to observe, however, that during the ten days of these experiments, both the barometer and the thermometer were tolerably steady.

The following table exhibits the volume of carbonic acid gas, in 100 parts of the air expired from my lungs during each of the ten days, at 11 o'clock A. M.:—

	CARBONIC ACID.	
1	4·64	per cent.
2	4·70	“
3	6·07	“
4	3·27	“
5	5·26	“
6	2·05	per cent.
7	2·39	“
8	3·85	“
9	3·05	“
10	7.16	“

I was not a little surprised at these results: the differences being so much greater than I had anticipated. The mean of the whole is 4·24 per cent., which, therefore, I am disposed to consider as representing the mean quantity of carbonic acid gas, contained in 100 volumes of air expired from my lungs.

I was naturally induced to examine the air from the lungs of several other persons, in order to see whether there would be the same difference in theirs as I had observed with respect to myself. The gentlemen whose breathing was examined, were chiefly those who were occupied with practical chemistry in my laboratory. The following table exhibits the results obtained:—

	CARBONIC ACID.	
Mr. Thomas Thomson, (aged 14)	3·06	per cent.
Ditto, next day	3·61	“
Mr. J. Colquhoun, (aged 18)	3·09	“
Mr. Forrest, (aged 18)	2·10	“
Ditto, next day	5·19	“
Mr. Coverdale	2·54	“
Ditto, next day	1·71	“
Mr. Cargill	4·68	“
Mr. Bruce	5·46	“
Dr. Duncan	6·17	“
Dr. Short	6·85	“
Mr. Frazer	7·08	“

I prevailed upon two ladies to allow me to examine the air from their lungs. The first was an unmarried lady about seventeen years of age; the second a married lady, aged about thirty. The results were as follows:—

First lady - 2·35 | Second lady - 4·06

The diversity here is fully as great as in my own case, but the mean of the whole does not differ much from that of my own. I am disposed, therefore, to infer from these trials, that the average volume of carbonic acid gas, in 100 volumes of air, expired from the lungs at 11 o'clock A. M. is 4·24.

But, from Dr. Prout's experiments, (Annals of Philosophy, II., 328; and IV., 331,) it appears that the quantity of carbonic acid gas produced by respiration, is at its maximum at noon, and that its quantity at 11 A. M. is to the mean quantity for 24 hours, as 3·92 to 3·45. It is obvious, from this, that the mean volume of carbonic acid gas in 100 volumes of air expired, deduced from the preceding experiments, is 3·72.

I made a few trials to ascertain how much air different individuals are capable of forcing out of their lungs after a full inspiration. The quantity as might be expected, varies much in different individuals. But when the same individual repeated the trial, the result was very constantly the same. The following table shows the results:—

Mr. T. Thomson	150	cubic inches.
Mr. G. Thomson	163	"
Dr. Duncan -	180	"
Dr. Thomson	193	"
Mr. J. Colquhoun	200	"
Mr. Coverdale	200	"
Mr. Bruce -	200	"
Mr. Forrest -	200	"
Mr. Frazer -	200	"
Dr. Short -	210	"
Mr. Cargill -	250	"

200 cubic inches is the most common quantity; but in one case it amounted to as much as 250.

The number of respirations in a minute does not vary much in different individuals, being very nearly twenty, or rather between nineteen and twenty.

I believe that great errors have been committed in the attempts to determine the quantity of air thrown out of the lungs by a common expiration. I am satisfied that the quantity which I pitched upon from the experiments of Menzies, Lavoisier, &c., namely, forty cubic inches is far too high. I find, after a great many trials, (for it is very difficult to make a natural expiration when your attention is called to it,) that the quantity of air which I myself throw out at a natural expiration, is sixteen cubic inches. My nephew, Dr. Andrew Steel, who was a tall man, (about six feet,) with an expanded chest, also made many trials, and satisfied himself that his ordinary expiration was sixteen cubic inches. Messrs. Allen and Pepys determined the volume of air expired by them at an ordinary expiration, to be sixteen and a half cubic inches. From these facts, I think we are entitled to conclude that a common expiration does not much exceed sixteen cubic inches.

If these data be correct, and they cannot be very far from the truth, it will be very easy to calculate the quantity of carbon thrown out of the body daily by respiration. Allowing 20 respirations per minute, and 16 cubic inches of air taken in and thrown out at each respiration, we have 28,800 respirations in 24 hours, and 460,800 cubic inches of air passing through the lungs. Of this $\frac{3{\cdot}72}{100}$ or 17141·76 cubic inches are converted into carbonic acid gas. Now 100 cubic inches of carbonic acid weigh very nearly 50 grains: so that the weight of carbonic acid formed is 8,570·8 grains, $\frac{3}{11}$ths of which, or 2337·5 grains are carbon. This amounts to nearly nine ounces avoirdupois, or somewhat more than half a pound.

ARTICLE IV.

On the Changes produced in the Composition of the Blood by repeated Bleedings. By THOMAS ANDREWS, ESQ.

THE object of the following experiments is to determine with precision, the changes which are produced in the composition of the blood by repeated abstractions of large quantities of it from the general circulation. In the human subject, opportunities seldom occur of procuring proper specimens for examination, although the operation of venesection is so frequently performed, as in those cases where it requires to be repeated at short intervals the blood is generally in a morbid state. Instead of waiting for such casual occasions, I directed my attention to those animals in which the composition of the blood is nearly the same as in man, conceiving that similar results would in either case be produced. I selected the blood of calves for the purpose of experiment, and as it is the practice of butchers in this country to bleed these animals several times before they are slaughtered, I availed myself of this circumstance to procure suitable portions of blood. The animal is bled from a large orifice in the jugular vein, till symptoms of syncope appear, and the operation is in general repeated at intervals of twenty-four hours. It is once fed between each operation upon a mixture of meal and water, but this is often omitted before the last bleeding.

The appearance of the blood becomes greatly altered by the successive abstractions; the crassamentum is at first very large, and a portion of the red globules are unattached to it, but it progressively diminishes in bulk while its consistency increases, till upon the fourth bleeding it appears a small contracted ball immersed in a large quantity of serum, adhering to the stopper of the vessel in which it is contained, and presenting on its external surface an exact cast of the interior of the vessel.

The following analyses were performed by the same method that I formerly employed in a set of experiments on the blood of Cholera patients, which were published in the Philosophical Magazine for September 1832. They are nearly all a mean of two separate analyses which seldom differed from each other more than 0·5 per cent.

A calf was bled four times; between the first and second bleedings a week elapsed, but the rest took place at intervals of twenty-four hours, and the animal was fed between each operation. The composition of the serum and blood at each bleeding is exhibited in the following tables:

SERUM.

	FIRST.	SECOND.	THIRD.	FOURTH.
Water	92.19	93·96	93·81	94·18
Albumen and Salts	7·82	6·04	6·19	5·82
	100·00	100·00	100·00	100·00

BLOOD.

	FIRST.	SECOND.	THIRD.	FOURTH.
Water	81·36	85·49	87·41	89·25
Albumen and Salts.	6·89	5·50	5·77	5·52
Red globules & fibrin	11·75	9·01	6·82	5·23
	100·00	100·00	100·00	100·00

The serum had at the third bleeding, a specific gravity of 1·020, and at the fourth, of 1·017. At the third bleeding, the specific gravity of the blood itself was 1·031.

The next calf whose blood was examined, was nine weeks old. I did not procure any blood from the first bleeding. The third bleeding was twenty-four hours after the second, and during that period, the animal was once fed; twelve hours afterwards it was bled a fourth time, but it received no more food:

SERUM.

	SECOND.	THIRD.	FOURTH.
Water . .	93·32	94·39	94·59
Albumen and Salts	6·68	5·61	5·41
	100·00	100·00	100·00

BLOOD.

	SECOND.	THIRD.	FOURTH.
Water . .	82·05	89·14	88·92
Albumen and Salts	5·85	5·29	5·06
Red Globules and Fibrin	12·10	5·57	6·04
	100·00	100·00	100·00

The albumen and salts it is evident, decrease at each bleeding; the diminution is, however, very variable, and even after the fourth time, does not amount to one per cent. and a half. In the globules, the same diminution takes place, but to such a degree that they are at least reduced to less than one half their original quantity. To this principle, a remarkable exception occurs in the composition of the blood taken at the last bleeding of the second calf, where the globules are slightly increased above the preceding analysis; but it will be observed, that the animal received no food during the intervening period, from which the blood might obtain a fresh supply of serum, while the tendency of the different excretions of the animal was to drain from the circulating mass its aqueous part, and thus to increase the apparent quantity of the globules. This explanation is confirmed by the following analysis.

A calf three weeks old was bled twice before it was killed, twelve hours elapsed between the two bleedings, during which time it obtained no food:—

SERUM.

	FIRST.	SECOND.
Water	92·48	93·35
Albumen and Salts	7·52	6·65
	100·00	100·00

BLOOD.

	IRST.	SECOND.
Water	82·48	83·47
Albumen and Salts	6·70	5·95
Globules	10·82	10·58
	100·00	100·00

The globules have here it is true diminished at the second bleeding, but so slightly, that we may attribute this circumstance to the unassimilated chyle which must have been present in the system. In the former case, the animal had been exhausted by previous depletions, and hence possessed no store from which the blood could derive even a small portion of serum, as in the latter instance.

Article V.

History and Analysis of the Vanadiate of Lead. By

Robert D. Thomson, M. D.

When the history of the brown lead mineral of Zimapan is considered, it appears not a little remarkable that Vanadium should have remained for nearly thirty years in obscurity, after the idea of its existence was suggested. But the discovery of the metal within the last few years, is a striking proof of the improvement in chemical analysis, and of the assiduity and careful scrutiny with which the whole material world is in progress of being examined.

Humboldt, under the date of 14th November 1803, published in Gehlen's Journal, a notice of the analysis of a brown mineral from Zimapan, by Del Rio, in which the Mexican chemist it was stated, had discovered a new metal. The mineral was considered similar to specimens from Schoppau in Saxony, Hoff in Hungary, and Pollaven in Brittany.*

André del Rio appears to have examined the Zimapan mineral in 1802, and to have written a memoir in which he expressed his opinion that this substance was not a phosphate, and that it contained neither uranium nor chromium; and stated that he procured from it 14·8 per cent. of a new metal, which at first he called *Panchrome*, on account of the variety of colours presented by its oxides and precipitates, and afterwards *Eritrone*, because it formed with alkalies and earths, salts which became red either by heat or by acids.† But having read in the work of Fourcroy that the chromates afford by evaporation yellow or red salts, he came to the conclusion in 1804, that the brown mineral was a chromate of lead, with an excess of base, in the state of protoxide of lead.‡

In his Spanish translation of the Third Edition of Karsten's Mineralogical Tables, published in Mexico in 1804, he used language still more strongly opposed to his original opinion, and affirmed that the mineral consists of

Oxide of lead	80·72
Chromic acid	14·80
Arsenic, oxide of iron, and muriatic acid	4·48
	100·00

He found the quantity of arsenic to amount sometimes to two per cent., and always observed its presence, both by distillation and the blow-pipe.

It is quite obvious, from these two separate recantations, that Del Rio was convinced, from his own researches, that the substance which he at first considered new, was one which was already known to chemists, and that his original experiments were not valid. The observation, therefore, of Berzelius, that Del Rio was induced to alter his opinions in reference to the composition of the Zimapan mineral, out of respect to scientific authority is incorrect.*

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* Gehlen's Neues Allgemein journal der Chemie, 6th part, vol. ii. 695.

† Annales de Ciencias Naturales de Madrid, No. 19, February 1804. Annales des Mines, iv. 499.

‡ Annales de Ciencias, No. 19.

§ Gilbert's Annalen der Physik, lxxi. 7.

The *Annales de Ciencias Naturales* of Madrid, the medium through which Del Rio communicated the change of his views, although published by the Spanish botanist Cavanilles did not find their way among chemists in general.

In the *Journal de Mexico* of the 11th September 1811, Del Rio published a true statement of the case, an extract of which was given in the *Annales des Mines*, (IV. Vol. for 1819,) transmitted by Alaman a Mexican mineralogist.

Collet Des Cotils, who had heard of the discovery of Del Rio, but unaware of the repetition of his experiments, having been furnished with a specimen of the mineral, analyzed it and published his results in 1805, a year after the corrected analysis of the Mexican chemist had appeared.†

Des Costils found the mineral to afford before the blow-pipe upon charcoal, *sometimes* a slight smell of arsenic, and to be speedily reduced.

Heated with borax, it dissolved readily, and gave it a light emerald-green colour. His method of analysis was as follows: A portion of the mineral in powder, having been digested with the assistance of a gentle heat, in dilute nitric acid, the whole of it dissolved, forming a clear yellow solution with a tinge of green, except a small quantity of a reddish matter, which he found to be oxide of iron, containing a little silica and chromic acid. Into the solution, concentrated sulphuric acid being then poured, a white powder fell, which was recognised as sulphate of lead. The filtered liquor afforded no precipitate with ammonia. The excess of ammonia was dissipated, and the acid thrown down by nitrate of lead. The precipitate was yellow, resembling the chromate of lead, and contained some sulphate of lead, which was removed by taking up the chromate, by digestion in nitric acid. In another experiment, the mineral was dissolved in muriatic acid; the excess of acid removed, and the mineral acid thrown down by nitrate of silver. A fine red precipitate was the consequence. With nitrate of mercury, a yellowish compound was formed.

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* Kongl. Ventenskap. Acad Handlingar, 1831—1

† Annales de Chimie, liii. 268.

To determine the quantity of muriatic acid, a new portion was dissolved, and the solution was precipitated by nitrate of silver. The products of the analysis were:—

Metallic lead	69·0
Oxygen, (supposed)	5·2
Oxide of iron, insoluble in nitric acid .	3·5
Muriatic acid	1·5
Chromic acid	16·0
	95·2
Loss	4.8
	100·00

Without dwelling upon the method of analysis adopted by the French chemist, which was liable to great inaccuracy, it may be sufficient to recapitulate the grounds upon which he concluded that the acid contained in the mineral was identical with chromic acid.

1. The compound of the acid with lead was yellow. It is now known that the chromate and vanadiate of lead are both similar in their colour, but identity of colour is not identity of composition.

2. Nitrate of silver produced a red precipitate. Chromate of silver varies in colour according to the temperature at which it is precipitated; being reddish brown when thrown down from a hot solution, red with a tinge of purple in its cold state, and carmine red with excess of acid.

The vanadiate of silver is likewise variable in colour; being yellow when neutral, but with excess of acid, deep orange yellow.

3. Nitrate of mercury produced a yellow precipitate. Now chromate of mercury is purple or deep red, and vanadiate of mercury is a fine lemon yellow. From this fact it is evident, that the conclusions at which Des Costils arrived were not authorized by the results of analysis, even in reference to the slender claims which variety in the colour of the precipitates of analogous acids has by itself to determine difference of chemical nature.

After the consideration of this analysis, it appears certainly extraordinary that the nature of the compound should so long have been considered as ascertained. So little attention, however, it appears had been paid to the subject by mineralogists, that Lucas in his *Tableau Methodique des especes Minerales*, published in 1813, places the Zimapan mineral under phosphate of lead, and even in 1817, Breithaupt committed the same mistake.* After the analysis of Des Costils this interesting mineral remained in comparative oblivion till April 1830, when Professor Sefström, while examining iron from the Mine of Taberg in Smâland, introduced a new substance to the acquaintance of chemists, by the discovery of Vanadium.†

In the begining of 1831, Wöhler appears to have subjected the brown lead mineral from Zimapan to analysis, and to have concluded that it was a compound of vanadic acid, and protoxide of lead.‡

In the course of the winter 1830-31, Mr. Johnston states that his attention was directed to a mineral from Wanlockhead, which he obtained from a mineral dealer as an arseniate of lead, and that he procured by analysis, what at first he considered impure oxide of chromium; but having repeatedly attempted to separate the chromium in an insulated state, and several properties appearing which were distinct from those of chromium, he concluded that it was a new substance.§

Having finished the history of the discovery of the vanadiate of lead so far as I am acquainted with it, I proceed now to the consideration of the properties and composition of such specimens as have been subjected to examination.

1. The only quantitative analysis of the native vanadiate of lead which has hitherto been published, is that of Berzelius. The specimen examined was from Zimapan, and possessed little colour, but it was mixed with oxide of iron, which gave it a brown appearance.‖ Nothing is said of its density, but Breithaupt under the title of Vanadiner blei spath, states the specific gravity of the Zimapan mineral at 6·831.¶ The process of the Swedish chemist was to dissolve

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* Del Rio's Letter to Gilbert, 1. Annalen der Physik und dér physikalischen chemie, lxxi. 7.

† Ann. de chim. lvi. 105.

‡ Ann. de chim. xlvi. 111.

§ Edinburgh Journal of Science, v. 166.

‖ Kongl. Vetenskap. Acad. Handl. 1831. Annal de Chim. xlvii. 402.

¶ Vollständig characteristik des Mineral Systems, 54—1832, 8vo.

the pulverised mineral in dilute nitric acid; to precipitate the chlorine by nitrate of silver; to throw down the excess of silver by muriatic acid; to replace the volatilized nitric and muriatic acids by sulphuric acid; evaporate to dryness, and fuse the residue with sulphate of potash, in order to separate the lead, and to estimate the quantity of acid by the loss. The results of the analysis were,

Chloride of lead	Chlorine	2·53	9·93
	Lead	7·40	
Oxide of lead			67·99
Vanadic acid			21·34
Impurity			·73
			100·00

With some corrections, the analyst considers this equivalent to,

Chloride of lead	25·33
Vanadiate of lead	74·00
Impurity	0·67
	100·00

No phosphoric acid was detected in it, and a mere trace of arsenic acid was present.

2. Vanadiate of lead from Wanlockhead according to Mr. Johnston, is found in two states. 1. In the form of mamillæ, from the most minute size to that of a pin-head, sprinkled over a surface of calamine. The specific gravity 6·99 to 7·23. Opaque; varying in colour from straw-yellow to a reddish-brown; lustre resinous; streak white. In the finer specimens, the mineral appears in groups of six sided prisms. 2. In the second state in which it occurs, it resembles peroxide of manganese when earthy and porous, presenting an amorphous and rounded appearance; colour, steel-grey, fusing before the blow-pipe like the first variety, and retaining its yellow colour on cooling. The mineral was found in an abandoned lead mine, but only in one spot, about six fathoms in length, where the vein presented the appearance of having been disturbed by violent causes.

3. Hausmann noticed a mineral associated with red lead ore, which he suspected to be chromate of lead. It possessed a dark yellowish, or liver brown colour, occurring in small botryoidal and stalactitic forms, glistening feebly in-

ternally, or glimmering and resinous; fracture flat, conchoidal or uneven; opaque, soft, streak sisken-green. He conjectured that it was similar to the Zimapan mineral, and there can be no hesitation in admitting that his suspicions were correct.*

Native vanadiate of lead has been recently obtained at Beresow, near Katharinenburg in the Uralian Mountains, and its mineralogical characters have been investigated by Gustav Rose.† Among the lead ores in the gold mines, a green ore of lead is found, which crystallizes in double six sided prisms. It melts before the blow-pipe, crystallizing on cooling, and contains some phosphoric but no arsenic acid. In a specimen brought from Beresow, Rose observed the six-sided prisms on one side green, and on the other brown. Having tried them before the blow-pipe, he found the brown crystals to be vanadiate of lead. They are regular six-sided prisms, some of them very small, others larger. The crystals of greater size are found near the lead ore, and contain a nucleus of the ore. The crystals possess a chesnut-brown colour, a shining lustre, especially the small ones, and have the same hardness as the grey lead ore. Before the blow-pipe the mineral decrepitates strongly, melts upon charcoal into a globule, and the lead is reduced.

With salt of phosphorus it fuses in the outer flame into a glass, which when hot is reddish yellow, when cold yellowish green; and in the inner, into a glass possessing a chrome green colour.

In nitric acid it dissolves readily. The solution gives with nitrate of silver, a considerable precipitate of chloride of silver. The filtered solution gives with sulphuric acid, a white precipitate of sulphate of lead, and then precipitated by suphuretted hydrogen, a brownish red precipitate of sulphuret of vanadium. Rose concludes from these characters that the mineral he examined was identical with the brown lead mineral from Zimapan. The vanadiate of lead of Beresow is found in crevices in granite, which communicate with the quartz veins in which gold is found.

The mineral is liable to be confounded with the lead ore, because both substances crystallize in six-sided prisms, and both are combinations of a salt of lead with chloride of lead. Rose considers the Beresow mineral to correspond with that from Zimapan.

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* Journal de phys. lxiii. 38. Jameson's Mineralogy, iii. 413.

† Poggendorff Annalen der Chemie, xxix. 455.

4. The mineral which I am now to describe, was derived from a different locality from any of those mentioned. It was brought to Glasgow by Mr. Doran, an Irish mineral dealer, who stated that he had procured it in an abandoned lead mine in the county of Wicklow in Ireland, and is now in Dr. Thomson's cabinet.

Its colour is light brownish yellow, streak white. Commonly it appears in the form of small rounded masses or spheres placed on a surface of phosphate and arseniate of lead; but sometimes it is crystallized in six-sided prisms. Opaque with some translucence at the edges, brittle. The fracture is even or often flat conchoidal. Lustre resinous. Hardness 2·75. The specific gravity I found by one trial 6·675, by another 6·651, which numbers approach each other so nearly, that I am disposed to consider the true density of vanadiate of lead to be 6·663.

When exposed to the action of the blow-pipe on charcoal, it fuses with considerable frothing into a bead, which is precisely similar to the mineral itself. If the fusion is continued the matter spreads on the charcoal, and possesses at last a dark scoriacious aspect. When the blast is continued and carbonate of soda added, globules of metallic lead are produced and a black scoria remains.

With borax fuses into a bead, which is transparent and red while in fusion, but on cooling it becomes suddenly opaque and deep blue, when the proportion of vanadiate is considerable; but emerald green if it be small.

With salt of phosphorus in small quantity, it fuses into a fine emerald green transparent glass.

30 grains of the mineral carefully broken, and separated from the substance forming the basis on which the round masses were placed, were pulverized and digested in a flask on the sand bath with pure dilute nitric acid. The whole of the powder speedily dissolved, forming a deep orange solution, with the exception of a minute portion of a yellowish coloured matter, which remained in the bottom of the flask. The contents of the flask were transferred into a large watch glass.

After remaining at rest for a short period the supernatant liquor was drawn off, and the residue washed with repeated additions of pure distilled water. The insoluble matter when dried on the sand bath, possessed a brown colour, and weighed 0·07 grain. This lost by a red heat 0·02 grain, leaving for the weight of the anhydrous powder 0·05 grain. Before the blow-pipe this substance fused with carbonate of soda into an oblong green mass, which became somewhat lighter coloured by a continuance of heat, and with borax and salt of phosphorus into a light green glass bead. Hence, it appears to have consisted principally of vanadic acid, mixed however with some impurity, as is obvious from the action which was presented with carbonate of soda.

The liquid which had been drawn off from the insoluble matter, as well as the washings, was concentrated and precipitated by nitrate of silver, when a white substance fell, becoming curdy by agitation. This precipitate was well washed, and when dried on a watch glass by the heat of the sand bath, weighed 3 grains exactly. It was melted by the heat of a spirit lamp and lost 0·02 grain, leaving of dry chloride 2·98 grains. Now 18·25 : 4·5 : : 2·98 : 0·734 = chlorine. After the separation of the chloride of silver, the liquid was evaporated to dryness. The residue dissolved readily in water, to which a few drops of nitric acid had been added, leaving, however, a greyish powder, which proved to be oxide of silver derived from the excess of nitrate of silver, and was separated by filtration.

A drop of muriatic acid occasioned no precipitate in the liquor. Through the solution, which was yellow coloured after concentration, a current of sulphuretted hydrogen was passed for four hours. A copious precipitation of sulphuret of lead ensued, and the supernatant liquid assumed a fine transparent blue colour. The precipitate was washed with repeated additions of water, allowing it to subside, and then drawing off the liquid. The sulphuret of lead weighed in a watch glass after being subjected to the heat of the sand bath 26·02 grains. 10 grains carefully heated over a spirit lamp, for some time after it ceased to give off sulphur, lost 0·37 grain. By another trial 10 grains lost 0·40 grain by a heat applied twice as long, so that in the first experiment the free sulphur had not been completely dissipated. This makes the loss upon the whole precipitate, supposing it deprived of all moisture and free sulphur 1·04 grains = 24·98 grains sulphuret of lead. 9·6 grains of the heated sulphuret were digested in nitric acid, with a drop or two of sulphuric acid. The resulting precipitate was thrown on a filter. After edulcoration and heating, it weighed 11·56 grains sulphate of lead. Hence, 24·98 grains sulphuret of lead in this case are equivalent to 30·08 grains sulphate of lead, and in the latter are contained 22·164 grains protoxide of lead.

I have adopted the method of determining the quantity of lead contained in the mineral, by converting the sulphur into sulphuric acid, and obtaining the lead in the state of a fixed salt, because it appears to be more free from objections than when the proportion of lead is calculated from the precipitated sulphuret of lead, whose definite composition after exposure to a considerable temperature might be called in question. For in this experiment which was made with great care, the proportion of oxide if estimated from the sulphuret would amount to 23·314 grains.

According to M. Fournet, sulphuret of lead when exposed to a strong heat, volatilizes in the manner which is precisely exhibited by the following formulæ: $12\,Pb + 24\,S = (4\,Pb + 8\,S + (8\,S))$ where the portion $8\,S$ separates at first followed by $4\,Pb + 8\,S$ leaving $8\,Pb + 8\,S$ which by a continued heat loses $(2\,Pb + S) + 2\,Pb + 4\,S$.*

Through the solution filtered from the sulphate of lead a current of sulphuretted hydrogen was passed, but without effecting any precipitation or colouration, indicating the absence of arsenic in the mineral. I am disposed to consider the impurities which have been observed in some analyses, as proceeding from the portions subjected to examination having been mixed with the base upon which the mineral was placed. In some of the specimens which I examined, the phosphate and arseniate of lead, forming the seat of the vanadiate of lead, extended above the base of the mamillary masses towards their interior, but as they differed very considerably in colour, the separation of the latter from the former was easily accomplished.

The liquid after the separation of the sulphuret of lead was evaporated. It assumed a blue colour, and when only a small portion of fluid remained it gradually became green, and on

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* Annales de Chimie et de Physique, lv. 413.

being largely diluted re-assumed its blue tint. As from the appearance of the colours in the solution, it was evident that some of the acid had parted with a portion of its oxygen, and been reduced to the state of oxide, it was necessary to render the whole of a homogeneous nature. For this purpose a quantity of oxalic acid was added to the liquid, and to ensure the total conversion of acid into oxide, a current of sulphuretted hydrogen was passed through it. The solution became muddy and a dark precipitate appeared, which was separated by filtration, and when heated was completely volatilized, and was obviously sulphur. The solution possessed now a rich blue colour. It was concentrated on the sand bath, in order to drive off the excess of sulphuretted hydrogen. Nitrate of lead afforded no precipitate, indicating the absence of sulphur and phosphoric acid. An excess of carbonate of soda was then added, which precipitated the hydrous oxide of vanadium, in the form of a bulky greenish brown precipitate, becoming black by exposure to heat. It was thrown on a filter and washed with hot water. After exposure to a red heat, it weighed 21·39 grains. According to the numbers which Berzelius has attached to the oxides of vanadium, we have, in order to arrive at the quantity of acid which is equivalent to this portion of oxide, the following proportion:—
10·5 : 11·5::21·39 : 23·436 = vanadic acid.

The results of the analysis therefore are:—

Chlorine . . .	·734	2·446
Protoxide of lead	22·164	73·880
Vanadic acid . .	7·031	23·436
Insoluble matter .	·048	0·160
	29·978	99·923.

If we view the acids as forming subsalts with the bases, with which the numbers nearly agree, the composition of the mineral will be

Chlorine . . .	2·475	1 atom
Lead	14·292	2 "
Protoxide of lead	59·361	8 "
Vanadic acid . .	23·712	4 "
Insoluble matter	0·160	
	100·000	

or Dichloride of lead .	16·767
Divanadiate of lead .	83·073
Insoluble matter . .	0·160
	100·000

equivalent to

1 atom Dichloride of lead, and
4 atoms Divanadiate of lead

and the formula, $Pb^2 Ch. + 4 Pb^2 V.$

ARTICLE VI.

Transmission of Heat through different Solid and Liquid Bodies. By M. MELLONI. Ann. de Chimie, lvi.

RADIATING heat passes immediately, and in greater or less quantity, through a certain class of solid and liquid bodies. This class is not precisely identical with diaphanous bodies, as opaque plates or such as possess only a slight transparency, are more *diathermanous*, that is to say, more permeable to radiating heat than other plates completely transparent.

Different species of calorific rays exist, which are all emitted simultaneously, and in different proportions by burning bodies. Rock-salt formed into a plate, and successively exposed to rays of the same force, proceeding from different sources, transmits immediately, the same quantity of heat. A plate of every other diathermanous substance, placed in the same circumstances, transmits quantities more feebly in proportion as the temperature of the radiating source is less elevated; but the differences of each transmission diminish in proportion to the thinness of the plate. From whence it follows, that the different rays of heat from different sources are intercepted in greater or less quantity, not on the surface, and from an absorbing power, which varies with the temperature of the source, but even in the interior of a plate, by an absorbing power similar to that which preserves certain kinds of light in a coloured medium.

We arrive at the same conclusion in considering the loss which the rays of heat from a source of high temperature sustain in passing through the successive elements of which any other diathermanous plate besides rock-salt consists. In short, if we imagine the plate to be divided into several equal slices, and if we examine by experiments, the proportion of the quantity lost, to the quantity falling upon these slices, we shall find that the loss thus calculated, decreases rapidly with the distance from the surface, but the decrease becomes less sensible, so that the loss ought to take an invariable value when the rays arrive at a certain depth. This is precisely what happens when ordinary light enters a coloured medium, the loss of intensity being at first great, and gradually diminishes. A third proof of the analogy which exists between the action of diathermanous bodies upon radiating heat, and the action of coloured media upon light, is derived from successive transmission through heterogeneous screens. The luminous rays which proceed from a coloured plate pass abundantly through a second plate similarly coloured, and undergo a great absorption, in proportion as the colour of the second plate is more or less analogous to the colour of the first.

There is only one diaphanous and colourless body, which acts in the same manner on luminous and calorific rays. All others allow every species of light to pass indistinctly, but they absorb certain rays of heat, and transmit others. Thus, we find in these bodies a true calorific colouring power, which is invisible, and is called by the author, *diathermansie*.

The following table exhibits the relative diathermanous power of different substances:—

Rock-salt, clear,	92
Flint-glass, clear,	67
Sulphuret of carbon, colourless,	63
Chloride of sulphur, dark,	63
Rock-crystal	62
Rough topaz, clear-brown,	57
Brazil topaz, clear,	54
Crown-glass, clear,	49
White agate, transparent,	35
Barytes spar	33
Oil of turpentine	31
Nut oil, yellow,	31
Oil of colsa	30

Aqua marine, blue,	29
Borax, dull,	28
Tourmaline, Brazil,	27
Balsam Capiva	26
Adularia	24
Ether	21
Gypsum	20
Sulphuric acid	17
Nitric acid, Alcohol, Citric acid	15
Alum	12
Pure water	11

The colours introduced into a diaphanous medium always diminish more or less its diathermanity; but they do not communicate the property of detaining certain kinds of rays of heat. They act upon the transmission of radiating heat, as brown substances on the transmission of light. There is an exception in opaque green and black glass, but these two colouring matters appear to act by modifying the diathermanity, a quality which is independent of colouration. The quantity of radiating heat which traverses two polarizing plates of tourmaline does not change, when the angle of the axes of crystallization is increased; the rays of heat cannot be polarized by this mode of transmission, and in this respect they differ totally from the rays of light. They resemble light however, in the property of refracting, which is proved by rock salt, the only one of the diathermous bodies capable of transmitting calorific rays from any source.

In ordinary prisms they cannot produce refraction except upon a certain portion of radiating heat, for the glass intercepts several kinds of rays of heat proceeding from very hot sources, and absorbs almost the whole heat which is emitted by bodies below incandescence. Hence, the doubt which has been hitherto entertained upon the refrangibility of obscure heat.

Article VII.

Products of the Distillation of Pit Coal. By F. F. Runge.

(*Poggendorff*, *Annalen* xxxi. 65.)

From the oil of pit coal rectified over oxide of copper, three bases and three acids are partly separated, or are partly formed, which differ in their chemical properties from any substances hitherto observed.

BASES.

1. *Cyanol.*

Cyanol (blue oil) is a volatile substance, almost destitute of any peculiar smell, neutralizing acids and forming salts which partly crystallize. It produces in a solution of muriate of lime a blue colour, which is removed by an excess of chlorine. The salts of cyanol dissolve in solutions of muriate of lime, producing a fine violet blue colour, which by free chlorine is converted into orange. They impart to the colourless solution of the white pith of the elder and pine wood, an intense yellow colour, which is not destroyed by chlorine, at least under the circumstances in which other organic colours disappear Thus, a piece of Turkey red cotton speedily loses its colour, when after being moistened with oxalic or tartaric acid it is immersed in a solution of muriate of lime. Paper, cotton, linen, wool, and silk are not coloured yellow. The effect of the salts of cyanol in colouring pine wood is so strong, that a drop containing only $\frac{1"}{500'000}$ of cyanol produces a distinct yellow colour in the wood. The yellow colouring is not imparted to the fibrous part of the wood, but to a peculiar matter in the wood which also exists in other species of trees. The resin has no connexion with this colouring power.

The oil of pit coal contains a great quantity of cyanol, whose presence is easily detected by mixing 1 part of oil with a solution of 20 water and 1 part muriate of lime. The oil becomes dark red and the solution assumes a blue colour, similar in intensity and appearance to the moist ammonia sulphate of copper. It is changed by the muriate of lime into an acid which forms compounds possessing a blue colour.

Cyanol is very readily detected by muriatic acid, when coal oil is mixed with the latter in the proportion of 3 volumes to 1. The acid becomes brown; and a splinter of fir wood introduced into the solution, has the yellow colour already described communicated to it, thereby indicating the presence of cyanol.

2. *Pyrrol.*

Pyrrol (red oil) in a pure state is a gaseous body possessing the odour of turnips, *(märkochen rüben)* and may be detected by dipping a stick of fir moistened with muriatic acid in a vessel containing pyrrol, when it is tinged purple red, and which like the effect of cyanol is not removed by chlorine. Paper, &c., treated in the same manner remains colourless. The colouring power of the compounds of pyrrol is not less strong than that of cyanol. Nitric acid produces in the aqueous solution of pyrrol a red colour.

It is difficult to detect pyrrol in coal oil, as the cyanol and carbolic acid render its re-action indistinct, but it may easily be discovered in water which has been employed to wash common street gas, by saturating it with muriatic acid, and dipping into it a stick of fir. A purple red colour is occasioned.

Pyrrol forms the principal constituent of empyreumatic ammonia, and when its peculiar smell is known, it may be distinguished among the odours which are disengaged by the distillation of bones and horns. Pyrrol is also contained in tobacco oil.

3. *Leucol.*

Leucol (white oil) has been so termed because its re-action is colourless. It does not produce a blue colour in muriate of lime, nor does it communicate to fir any tinge. Leucol is an oily substance, and is well characterized by the salts which it forms with acids. It loses its smell by its combination with acids, and forms with oxalic acid crystallized salt.

When brought in contact with the moist skin, acetate of Leucol emits a smell like phosphorus.

ACIDS.

1. *Carbolic Acid.*

This acid is a colourless oily substance, sinking in water. Its smell is extremely empyreumatic; it is caustic and burning, and has a strong action on the skin. When the skin is rubbed with it a feeling of burning is felt, and a white spot is produced, which on being touched with water becomes red, and in some days desquamates. In this respect it corresponds with creosote, but differs in being acid; in being precipitated by acetate of lead, and in not being altered by ammonia or the atmosphere, and in being converted by nitric acid even diluted into a reddish brown matter.

Carbolic acid dissolves in water. The solution is colourless and the acid is easily rendered conspicuous with nitric acid. The water is at first yellow or orange, and afterwards reddish brown; a stick of fir plunged in dilute carbolic acid, takes after being moistened with muriatic acid in half an hour, a blue colour. The vapour of muriatic acid also tinges shavings moistened with carbolic acid of a blue colour. This tinge withstands the action of chlorine in a high degree.

The salts of carbolic acid are colourless, and many of them can be crystallized; their aqueous solutions present the same appearances with fir as the solution of carbolic acid. Carbolic acid precipitates albumen, prevents organic substances from putrifying, and removes the putrid smell of meat when digested with an aqueous solution, much better than chlorine. The presence of carbolic acid may be detected in coal oil by mixing it with lime water, filtering and evaporating to the consistence of a syrup. Muriatic acid separates impure carbolic acid from this mass, which is impure carbolate of lime.

2. *Rosolic Acid.*

This acid (rose oil) is a product of the chemical decomposition of coal oil, and contains what is remarkable, a true pigment. It produces red and lake colours which are equal in beauty to saffron, cochineal and madder.

Rosolic acid is a resinous mass which may be reduced to powder, and assumes an orange yellow colour.

The principle from which rosolic acid is formed has not yet been detected; but its presence may be easily demonstrated by mixing lime water with coal oil, filtering the watery solution, and allowing it to stand for some hours. The colourless or yellow solution now becomes red; which is occasioned by the precipitation of the rosolate of lime.

3. *Brunolic Acid.*

Brunolic acid is formed in the same way as the rosolic. It is vitreous, shining, easily pulverized, and resembles asphaltum. Most of the compounds of brunolic acid are brown and insoluble, while those of rosolic acid are red and soluble.

Besides these six substances, there is still another which has not been obtained in a separate state.

Separation of Cyanol and Leucol.

Mix together and agitate 12 parts of coal oil, 2 of lime and 50 of water. After 6 or 8 hours pass the liquid through a filter. It is of a brownish yellow colour and should be distilled to one half. The liquid which comes over consists of a thick oil, and a solution of it in water contains carbolic acid in combination with ammonia, leucol, pyrrol, and cyanol. Five distillations are required to separate the cyanol and leucol from this mixture. The first distillation is conducted with an excess of muriatic acid, by which means the pyrrol and carbolic acid pass over into the receiver, and the process is continued till the liquid passing over is no longer red, brown, or yellow, when it is to be mixed with nitric acid. The retort now contains a mixture of ammonia, leucol and cyanol in union with nitric acid. This mixture possesses a bright yellow colour, and should now be distilled with an excess of caustic soda. The three bases pass over into the receiver with the water, and in the retort remains the yellow ley with nitric acid. The matter is to be re-distilled with an excess of acetic acid, and the process is to be continued till the liquid passing over tinges fir wood. Acetate of cyanol and leucol collect in the form of a colourless solution in the receiver, while a great portion of the ammonia remains in combination with acetic acid forming a residuum.

The acetic acid salts are now to be converted into oxalates by distillation with oxalic acid. When the liquid which passes over tinges wood yellow, it is a proof that the bases are saturated. The liquid in the receiver is now to be gently evaporated to dryness. The mass consisting of oxalates of cyanol and leucol mixed with a little colouring matter and ammonia, should be reduced to powder digested with spirits, and thrown on a filter. The spirits and colouring matter pass through the filter and leave the salts. This digestion and filtration should be repeated until the liquid passing through is colourless. The funnel should then be transferred to another vessel, and spirits digested on the salts as long as any are dissolved.

Oxalate of ammonia now remains upon the filter, and the spirits contain in solution oxalates of cyanol and leucol, which by the evaporation of the spirits are obtained in crystals. These are to be dissolved in water and laid aside to crystallize. Fine needle crystals of oxalate of leucol first appear, and after some time crystals also of oxalate of cyanol make their appearance. The latter are in broad plates of a brownish colour, and change with muriate of lime to a violet blue, and turn wood to a yellow colour.

Should the two salts after separation not be quite pure, they should be repeatedly dissolved in alcohol and crystallized. To separate the two bases from the salts, it is only necessary to distil them with soda ley, when they pass over into the receiver with the vapour of the water.

Separation of Pyrrol.

It is extremely difficult to obtain pyrrol in a separate state, in consequence of its affinity for carbolic acid. To obviate the effects of the acid, it is best to saturate the empyreumatic ammonia which passes over from the distilled bones with an acid. The matter which passes into the receiver should be mixed in the first Woulf's bottle, after being filtered, and the discharged gases absorbed by caustic potash, or lime-water. By distillation, the pyrrol is carried into the receiver, forming a colourless solution, which produces a purple-red in wood. To purify the pyrrol, it should be distilled with muriatic acid, when muriate of pyrrol passes over. When distilled with caustic ley the pyrrol comes over pure.

Separation of Carbolic Acid.

Agitate together 12 parts of coal-oil; 2 of lime, and 5 of water, at intervals, for six or eight hours. The filtered liquid should be boiled down to a fourth part, filtered after cooling, and mixed with an excess of muriatic acid. Impure carbolic acid collects at the bottom of the vessel, in the form of a brownish oil. The supernatant liquid should be removed, the brown oil washed with water, and subjected to distillation. A milky liquid passes over, from which some colourless oily drops separate, which are pure carbolic acid. As much water is now to be added to the receiver as will dissolve the oil, and then the liquid precipitated with acetate of lead. Carbolate of lead is formed, which after being well washed, is subjected to dry distillation. The carbolic acid collects in the receiver in the form of a yellow oil, which after rectification, appears as a thick liquid, consisting of pure anhydrous carbolic acid. When the lead salt is not properly dried, water passes over with the acid.

This process is necessary to free it from the heterogeneous compounds in the coal-tar, which are ammonia, cyanol, pyrrol, and leucol. These are removed by the boiling. Creosote and sulphur are partly precipitated by the lead, and the rosolic and brunolic acids remain in the retort, while the water is separated by rectification.

Separation of Rosolic and Brunolic Acid.

The residue in the retort, after the last process, is to be boiled with water, dissolved in spirits, and mixed with lime-water. A rose coloured solution of rosolate of lime is formed, and brunolate of lime remains at the bottom, as a brown precipitate. From the rosolate of lime the rosolic acid is separated by acetic acid, and again combined with lime, whereby brunolic acid separates. The decomposition, by means of acid and repeated solution, should be continued as long as brunolic acid is observed. The rosolic acid is then collected on a filter, and dissolved after edulcoration and drying in alcohol. There remains on evaporation, a vitreous, hard, orange-coloured mass. The rosolic acid may also be separated by evaporating the solution of rosolate of lime to the thickness of syrup, and mixing it with ⅓ spirits. In the course of a day red crystals of the salt appear on the sides of the glass, which are to be removed, well washed, dissolved in water, evaporated, and treated with acetic acid and lime-water. The brunolic acid is separated from the brunolate of lime by digestion with an excess of muriatic acid. The brunolic acid separates in brown flakes, which for complete separation from the rosolic acid, must be repeatedly treated with lime and acid. The acids separated from the lime by muriatic acid, are dissolved in soda ley, and the solution is mixed again with muriatic acid, when a pure precipitate of brunolic acid falls, which may be completely purified by solution in alcohol.*

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* Reichenberg.(Schweigg. Journ. lxix. 19) has drawn the following conclusions with regard to pit coal 1 $\frac{1}{320000}$ of an ethereal oil is procured by distillation, with water which is identical with petroleum. 2. Petroleum is not a product of the

ARTICLE VIII.

On Pittacal, a new dye-stuff. (*Poggendorff's Annalen* xxxi.)

Pittacal (*πιττα* and *καλλος*) is a name which Reichenbach of Blassko has given to a substance which is obtained from impure picamare, or from portions of the oil of beech-tar, which are heavier than water. Dissolve them in spirits and add a drop of barytes water. The colourless liquid becomes immediately blue, and in five minutes assumes an indigo shade. When tar-oil is mixed with potash-ley till it acts, litmus is only slightly tinged acid, and the oil is placed in a solution of barytes; while the latter becomes pale-red, the oil on coming in contact with the air, is rendered blue, and in a few hours black. With dry hydrous barytes also, the tar-oil deprived of its acid by potash, assumes an indigo colour in the air; and lime, magnesia, potash, soda, ammonia, hydrous silica, give it a reddish or yellow colour. The cause of these colours depends on the presence of pittacal.

Pittacal is a dry, hard, brittle, dark-blue dye, of the appearance of indigo. It is destitute of smell and taste, and is not altered by a moderate heat; but in a high temperature carbonizing without an ammonical smell. In a pure state, it seems rather to be suspended than to dissolve in water. When well filtered, after some days, dark violet flocks separate, and the solution is then completely colourless. Litmus, turmeric, light and air have no effect upon it. Dilute acids, with the exception of nitric acid dissolve it; sulphuric acid producing a violet-blue, or carmine colour; muriatic acid a purple-red, and acetic acid an aurora-red. The last, by an excess of alkali, becomes again blue, and if ammonia is the alkali employed, the solution is a more delicate test for acids than litmus paper. In alkalies which precipitate it from acids, even from water, it is insoluble. The dark-blue compound with lime, dissolves with an aurora-red colour in acetic acid. An excess of ammonia

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burning of coal in the earth. 3. Artificial petroleum has so much resemblance to oil of turpentine, that perhaps, we may infer petroleum to have been the oil of turpentine of ancient times. 4. Eupion and petroleum are different principles. Rectified coal tar oil contains, with other substances, petroleum and eupion. 5. The coal strata have not been exposed to higher temperatures. 6. Petroleum wells appear to be the product of simple distillations of the coal strata through the natural heat of the earth.

restores the blue tint. Neither alcohol, ether, nor eupion dissolve it. Acetate of lead, salts of tin, ammonia, sulphate of copper, and acetate of alumina, precipitate it blue, which is not changed by an excess of ammonia. Pittacal is therefore useful as a dye-stuff. It fastens on cotton and linen very well with alumina and salts of tin.

ARTICLE IX.

On the acid nature of the Blood, and the distinction between Arterial and Veinous Blood. By R. HERMANN. *(Poggendorff's Ann.* xxxi.*)*

THREE years ago the author announced that he had discovered acid in the blood, but his position was not admitted by any chemist. In 1833, he took advantage of the presence of Dr. Stevens in Moscow to repeat his experiments. He found 1. That neutral tincture of litmus was coloured red by veinous blood taken from the arm of a healthy Russian aged 31 years.

2. The coagulum being rubbed up with distilled water boiled, and the solution containing the salts concentrated, the residue did not alter tumeric, and had a doubtful effect upon litmus paper.

3. 720 Gran of veinous blood fresh from the arm, were heated with a solution of muriate of lime in a pneumatic apparatus, and the gas extricated was collected over mercury. Potash absorbed, $\frac{1}{6}$ Russian cubic inch carbonic acid.

6. Veinous blood was coagulated at a high temperature, and the coagulum boiled with water and evaporated. The concentrated residue exhibited an acid nature to tincture of litmus, and to red litmus paper rendered red, an alkaline state. On examination, he discovered that the distilled water employed, contained phosphate of soda, and observed that he could produce this paradox, by adding to phosphate of soda some acetic acid. As the neutral phosphate of soda has an alkaline effect upon vegetable colours, he conceives that the acid re-action of the blood is to be attributed to the presence of acetic acid.

6. Tincture of litmus mixed with fresh serum, was rendered red. Red litmus paper became blue in the same

liquid. When heated in a pneumatic apparatus, carbonic acid escaped.

Dr. Stevens observed that the colouring matter of the blood is at first dark, but at last black. In this state it is obtained, when the coagulum is digested in distilled water and the salts thereby removed. The dark hue of the colouring matter is quickly changed to arterial red, when it is brought in contact with the neutral salts, and the red colouring matter becomes dark when added to acids, even carbonic acid. The veinous blood contains free carbonic acid, which can be removed, not only by exposure to the atmosphere, but even to hydrogen at common temperatures. By these means, he explains the difference between arterial and veinous blood. Hermann states, that he had made similar observations previously.

It has been shewn, (*Ann. de Chimie* xix.) that when arseniate or phosphate of soda appear in a solution, which with the addition of arsenic or phosphoric acid, exhibits an alkaline re-action, the liquid after crystallization is strongly acid; but if potash is the base of the crystallized salt, then the solution is alkaline. In the first case the salt is neutral, in the last, acid. Litmus paper moistened with a solution of biphosphate or binarseniate of potash becomes red, dried it becomes blue, when the salt by crystallizing takes up the acid, which reddened the litmus paper.

Article X.

Researches on the Blood. By L. Gmelin and F. Tiedemann, assisted by E. Mitscherlich. *Poggendorff's Annalen* xxxi.

Observers have differed with regard to the presence of carbonic acid in the blood.

Vogel found that under the receiver of an air pump, lime water was acted on by the disengaged carbonic acid.

Scudamore obtained in the same way, by means of barytes water, a precipitate of carbonate of barytes, equivalent to $\frac{1}{3}$ or $\frac{1}{2}$ cubic inch of carbonic acid gas, from six ounces of blood.

Brande procured from one ounce of arterial or veinous blood 2 cubic inches of carbonic acid.

On the other hand, Darwin could detect no such acid, and Dr. Davy asserts that it is neither extracted during the spontaneous coagulation of the blood, nor by the air pump, nor by coagulating the serum by heat, and that serum absorbs carbonic acid in greater quantity than pure water, which would not be the case if it was charged with carbonic acid.

Gmelin and Tiedemann examined with great care the blood of a dog taken from the femoral-vein and artery, and placed in different tubes under the receiver of an air pump. The result was that neither carbonic acid nor any other permanent gas was extricated. To ascertain the accuracy of Davy's statement with respect to the absorbing power of blood being greater than that of water, carbonic acid was allowed to stand over arterial blood for 5 days, when it was ascertained that 100 measures of blood absorb 120 of carbonic acid. The coagulum appeared blackish red, and the liquid portion was extremely clear.

Since blood contains no free carbonic acid, it was necessary to ascertain whether any existed in it in a combined state. Vinegar was added to each of the kinds of blood which had been collected, as in the former experiments, with every precaution to ensure accuracy, and was placed under a receiver. A quantity of carbonic acid escaped from both, more abundantly from the veinous than the arterial. The arterial blood mixed with vinegar, as well as the veinous blood, left over mercury for 3 weeks, was converted into a blackish brown mass without being separated into serum and coagulum. About the same period, without a knowledge of the Heidelberg experiments, Ed. Ch. F. Stromeyer obtained the same results.*

How do these facts agree with the present theories of respiration?

Lavoisier conceived that without coming in contact with the respired air, a liquid consisting principally of carbon and hydrogen is absorbed through the pulmonary membranes into the bronchi, and is converted into carbonic acid and water through the oxygen of the inspired air. As this theory does not render it necessary to suppose free carbonic acid in the blood, it is not at variance with the observations of Gmelin and Tiedemann, but the passage of gases into moist animal membrane, and also the immediate contact between air and blood cannot be well doubted of. Davy inferred from his results that air passes through the moist coats of the pulmonary vessels, and is taken up by the serum, the oxygen partly forming with the carbon of the cruor carbonic acid, and partly combining with the cruor. When he found that after the inspiration of hydrogen some carbonic acid was expired, though much smaller in quantity than after the inspiration of air, he concluded that veinous blood contains some free carbonic acid. According to the observations already given, it appears that the arterial and veinous blood contain no free acid but carbonic acid combined with alkali. And if we suppose acetic acid to be formed in respiration, (for we find it in the blood and in most organic liquids which are exposed to the influence of air in combination with alkalies), then must the veinous blood contain more alkaline carbonate than the arterial, when by the formation of acetic acid a portion of the alkaline carbonates will be converted into acetates.

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* Schweigg. Journ. fur Chem. lxiv. 105.

† Memoirs de l'acad des Sc. An. 1790, inserted in Scherer's Journal der Chemie x. 560.

By means of a barytes solution in an exhausted receiver, they estimated that 10,000 parts of arterial blood contain 8·3 of combined carbonic acid, and 10,000 parts of veinous blood 12·3 of acid in the same state, being in the proportion of 2 to 3.

They sum up their views of respiration in a few propositions:—

1. That in the pulmonary cells inspired air is absorbed into the moist membranous vessels, and is thus brought in contact with the blood.

2. The azote of the air is not sensibly absorbed by blood, but almost the whole of it remains in the cells. On the contrary, as oxygen is taken up by the blood abundantly, it flows out of the cells into the vessels in proportion to its absorption, and the mixture of gas remaining in the lungs must therefore contain more azote and less oxygen than the air.

3. The oxygen taken up by the blood combines partly with carbon and hydrogen, and forms carbonic acid and

water, and partly unites with the solid organic compounds contained in the blood. From these proceed acetic or lactic acid, which combines with a portion of carbonate of soda contained in the blood, and drives its carbonic acid into the cells.

4. The acetate of soda loses in its course through the different secreting organs its acetic acid, combines again with carbonic acid after undergoing many decompositions in its passage with the mass of blood through the body, and enters into the lungs on its return as carbonate of soda.

Is urea contained in the blood after the extirpation of the kidnies?

The authors directed their attention to this point, which it is well known has been decided in the affirmative by Prevost and Dumas, (*Ann. de Chim.* xxiii.)

On the 14th January 1832, the right kidney of a dog was removed, and in 14 days the wound healed.

The left kidney was cut out on the 11th February, and on the 13th the animal died. The substances taken from its body which were subjected to examination, were: 1. The liquid vomited; 2. The blood collected from the great vessels, amounting to 2 ounces; 3. The bile; 4. The contents of the small intestines. All these substances were dried separately on the water bath, and digested with hot water. The filtered liquid was precipitated by acetate of lead, and the lead removed by carbonate of ammonia. The fluid was evaporated to dryness, and treated with absolute spirits. The residue, after evaporation, was dissolved in a little water, and evaporated with nitric adid in a glass tube. The solution from the blood produced, with a drop of nitric acid, a yellowish, white crystallized precipitate, which was collected on a filter, washed with cold water, and dried. A portion of it heated in a platinum spoon left a trace of carbon; another part, heated with potash, disengaged no ammonia. A third portion was heated with water and carbonate of barytes. The mixture was digested with absolute spirits, and filtered This liquid, which was not precipitated by sulphuric acid, gave by spontaneous evaporation, long colourless needles, weighing 2 milligrames. They were soluble in water and spirits; were dissipated by heat, and precipitated by nitric and tartaric acids; they consisted therefore of urea.

From the vomited matter urea was procured, but in such small quantity as with difficulty to be appreciated. A brownish flocky precipitate was obtained from the bile, not completely resembling urea. No precipitate could be detected in the contents of the small intestines, or from the fæces.

Thus, the result of the German chemist's researches is, that urea can be formed without the aid of the kidnies. The French chemists, Vauquelin and Segalas, found no urea in the blood of a dog 48 hours after the extirpation of the kidnies, a circumstance which is probably to be ascribed to the short period which elapsed between the operation and the experiment.

No urea, or sugar of milk, in healthy blood.

Ten pounds of fresh blood from the cow, evaporated to dryness in the water bath, were digested with hot water, and again evaporated. The residue was taken up by water, and precipitated by acetate of lead. The filtered liquid was precipitated by carbonate of ammonia, and evaporated to dryness, and the residue digested with absolute spirits. The latter process was repeated, when by evaporation, a combination of soda, with a fatty acid, remained.

In the solution of the residue, nitric and oxalic acid occasioned no precipitate of urea, but they separated the fat acid (acid of oil?). It should be observed that, by this process, they had previously ascertained $\frac{2}{500}$ of urea, and $\frac{1}{100}$ sugar of milk to be appreciable. It appears, therefore, that cow's blood contains neither urea nor sugar of milk, or at least, in extremely minute quantity.

ARTICLE XI.

On the Magnetic Intensity of the Earth. By C. HANSTEEN.

(*Poggendorff's Ann.* xxviii.)

The interesting phenomena of the declination and inclination of the needle, lead us to the conclusion that in the southern as well as in the northern hemisphere, there are two points which appear to be the centres of the magnetic force. If we call these magnetic poles, then the earth possesses four poles. If the magnet is placed in the northern hemisphere to the westward of one of these points, the north pole is directed to the eastward; and if to the eastward, it points to the west. When the intensity of the degree of the inclination is investigated round the pole of the earth in parallel circles, we find that it continues to increase until the meridian is attained in which one of these points lies, where it reaches its maximum.

An important point to determine with regard to the magnetism of the earth, is the degree of its strength or intensity. For a long time it was disputed by the learned whether the magnetic force was equally strong over the whole earth's surface, or was different in different places. Mallet who was sent in 1769, to observe the transit of Venus at Ponoi in Russian Lapland, (*Nov. Comm. Petrop. tom.* xiv) allowed magnetic needles of 6″ to move through an arc of 20° to 24°, and found that for the four first oscillations 14″ less were required than at St. Petersburg. The difference, however, was so small that no inference could be drawn from it.

The French Academy gave instructions to the mathematicians along with La Perouse in 1785—88, to investigate the subject, and Lamanon* in a letter from St. Catharina stated that he had made a number of observations; but these as well as his subsequent ones were unfortunately lost by the disastrous shipwreck. Captain (afterwards Admiral) De Rossel made observations between 1790 and 1793 at Brest, Teneriffe, Amboyna, Java and Van Dieman's Land, and ascertained, that if we reckon the intensity at Amboyna in the neighbourhood of the equator unity, then it will be at Teneriffe 1·3, at Brest 1·4, and at Van Dieman's Land 1·6. Hence, it is inferred that the magnetic force at the equator is smaller than towards the pole. But as there is a difference of 5° of latitude between Brest and Van Dieman's Land, the former being in 48° and the latter in 43°, and as the intensity is greater at the latter than at the former place, it is evident that the intensity does not alone depend on the latitude, but that under one and the same latitude in one meridian it must be greater than in another.

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* This ill-fated individual who filled the situations of Natural Philosopher, Mineralogist, and Meteorologist, was murdered by the natives of Macuna, 11th December, 1787. See Dillon's Voyage—EDIT.

In 1799 Humboldt found that the oscillations of the needle became constantly slower towards the South as far as about 7° S. L. in Peru, where the needle remained horizontal. The direction of the magnetic force was also horizontal. Southward from this point it begins to increase.

The smallest intensity being taken as unity, then the greatest force was in Mexico 1·32, and Paris 1·35.

Captains Ross and Sabine increased our data with regard to the magnetic force, but from the observations of Parry and Franklin, Hansteen conceives that no accurate inferences can be deduced, as the needles changed their magnetic state. The results of these observations as well as those of Oersted and Erikson in Germany, France and England; of Keilhau, Böck, and Abel in Germany, Tyrrol and Switzerland; of Keilhau in Spitzbergen; of Hansteen in Norway, Sweden, Denmark and Finland; *(Pogg.* xiv*)* and of Sabine in Africa, have afforded materials for a magnetic chart upon which the intensities of the different parallels may be compared by what Hansteen terms *isodynamic lines*. From these it appears that the intensity in America in the same latitudes is much greater than in Europe, and that the isodynamic lines running parallel with the equator in America and in the Atlantic Ocean, pass towards the North-east, but again in Europe resume their parallelism with the equator. The line which represents, in the northern hemisphere, the intensity 1·5, a little to the north of Havannah, winds to the north-east by Iceland, and then east between Spitzbergen and the North Cape. This line of intensity again passes southward, and incloses the other magnetic north pole in Siberia. The definition of this line is in conformity with the observations made by Hansteen.

Some time before Hansteen's tour in Siberia, Captain King who was sent by the British Government to examine the coast between Rio de Janeiro and Valparaiso, supplied with Hansteen's apparatus for determining the intensity, communicated many of his observations, through the Admiralty, to Hansteen. Hansteen procured a very interesting suite of data from Captain Lütke, determined between the years 1826 and 1829, from Behring's Straits and Kamschatka, through the Southern Sea to the Philippines. Dr. Erman of Berlin, who travelled through Russian Asia, embarked at Kamschatka and returned by Cape Horn, communicated also much interesting matter. The Emperor of Russia sent a number of observers to the Caucasus, in 1829, under professor Kupffer. who were supplied with the proper instruments for ascertaining the magnetic force. Captain Freycinet supplied materials likewise.

Hansteen has fixed upon the smallest intensity observed by Humboldt as unity, although recent researches have led to the belief, that this is not the absolute minimum, but that we must look for this point in Southern Africa.

The point of greatest intensity is New York, where it amounts to 1·801. Yet this is probably not the maximum as the direction of the line appears to indicate, that the intensity on the West coast of Hudson's Bay may be as high as 1·9. If we follow the 60° of parallel from Hudson's Bay to Christiania, it will be observed, that this Latitude cuts the different curves which indicate the intensities 1·8 1·7—1·5—1·4.

The isodynamic line of 1·4 which passes from Jamaica and the Azores through England to Christiania, turns then easterly and cuts the 60 degree of latitude at St. Petersburg. In this parallel a minimum of intensity is observed between Christiania and St. Petersburg in the meridian of Abo. Following out this parallel to the east, the intensity is found to increase, being at Bogoslowsk 1·5, and at 120° east from Ferro 1·7. Between 120° and 130° it attains its maximum of 1·72, and further east it decreases, so that about 123° it is 1·7, and in the meridian of 168° 1·6.

About 167° it reaches another minimum = 1·56 at Olutorskoi. The greatest intensity observed in Siberia was detected by Lieut. Due at Wilwisk = 1·76. Hansteen infers from these data, that in the northern hemisphere, two magnetic mean points or poles exist, and that the Western Pole, in North America, exhibits a stronger intensity than the eastern one in Siberia.

The observations with respect to the magnetic force in the southern hemisphere are extremely scanty; those of King and Lütke only extending along the coast of South

America, while the whole of the Southern Atlantic, between South America and New Holland, is completely destitute of any magnetic notice. According to De Rossel, the intensity of Van Dieman's Land is 1·6. Tracing the 50° of latitude from South America to New Holland, we observe that the intensity about the meredian 290° east, must be somewhat above 1·5, and that it decreases to 0·9 about 30° east from Ferro.

Under Van Dieman's Land, 170° east from Ferro, it appears to be 1·7. Thus, it may be inferred that in the southern hemisphere there are two maxima of intensity on these two points, where the declination and inclination of the needle have indicated the existence of two magnetic poles.

In the neighbourhood of the equator at Rio Janeiro, Bahia, the Island of Ascension, and St. Thomas, the intensity is = 0·9. Through these points, if a curve be drawn, indicating this intensity, it will cut the equator at 30° east from Ferro, and traverse Africa and the Indian Ocean near the equator, and thence will pass through Java and Surabaya, where according to De Rossel it is 0·917. This line by reflection is curved to the south as far as 50° S.L., and gradually reaches Bahia. If we follow a meridian from North to South, we observe that the intensity gradually decreases, and again increases on the south of the equator; but they differ much in different meridians. The intensity in the meridian 300° at New York is 1·8, (40° N.L.) and 1·0 in 7° S. L. in Peru. In the meridian 40° the greatest intensity is 1·55, while in 20° or 30° S. L. the intensity is scarcely above 0·8, which appears the smaller minimum, using the term comparatively. Hence, the smallest intensity 0·8 in Africa, is to the greatest intensity 1·9 in North America, as 1 to 19 or 1 to 2·4.

Another remark is that the intensity upon the whole, is greater in the northern than in the southern hemisphere. Thus we find the intensity at New York in 40° North to be 1·8, while in the same southern latitude in New Holland the magnetic force is only 1·57. The same fact holds with regard to the Siberian pole; for on the borders of China south of the Baikal sea in 50° N. L. intensity is 1·6, but in the same southern latitude only 1·3.

In the course of his investigations upon the earth's magnetism, Hansteen has made the interesting remark that the Polar lights derive their origin from the four magnetic points on the earth's surface, where the maximum of intensity is observed, and that the irregular movements of the needle during the appearance of the Northern lights, indicate the most intimate connexion between them and magnetism. These movements of the magnet appear in the same instant at distant places, for Hansteen observed on the 26th August 1825, at Torneâ, a sudden diminution of the magnetic intensity, while M. Arago at Paris at the same moment remarked a great movement in the needle, and Holmbœ at Christiania, and Herzberg at Hardanger noticed an aurora.*

Lately it was determined at the request of Humboldt, that magnetic observations should be registered every hour at Berlin, Freiberg, Petersburgh, Kasan, and at Irkutsk an observatory is now in progress.

It is a point of some importance to attend to the relation between the mean temperature of a place, and its position in respect to the magnetic pole.

Mercury it is known freezes at Hudson's Bay in 55° N. L., which does not occur in Europe. In his journey in Siberia, Hansteen had the mercury in his thermometer frozen many days between Krasnojarsk and Nishne Udinsk. On the 30th of January in 55°¾ N. L. at Bagranowskaia, he froze three or four pounds of mercury. At Jakutsk in June 1829, Due and Erdman caused a well to be dug, and found the earth frozen at 30 feet, and where a thermometer fell below the freezing point, while in the air it was high. At Turnshansk (65°) Hansteen found the earth frozen considerably under the surface, while the temperature of the air was 25° R. (56°¼ F.) in the month of June. At Terra del Fuego the climate is very severe, although this island stretches from 23° to 55°, and is surrounded by the great ocean which tends to meliorate the climate. Hence it appears that the temperature in the vicinity of three of the magnetic poles, is much lower than in other places under the same latitude. With the fourth magnetic pole in the Indian Sea, we require the observation that there is in its neighbourhood no other land in a more southerly latitude than 30°. This idea of a connexion between the earth's magnetism and its temperature, has been taken up by Sir David Brewster; and in a copy of Hansteen's magnetic chart published by him in his journal, he has laid down two frigid poles in the northern hemisphere, the one in North America, the other to the North of Siberia. It may be asked, what is the cause of the low temperature at these points, and why does the magnetic pole change its condition? The principle cause appears to be that the greater magnetic intensity, the inferior temperature, and the aurora borealis proceed from a peculiar dynamic influence in the internal parts of the earth, which is yet unknown to us. If we had observations on the annual mean temperature for 200 years in different parts of the earth, especially in the greater geographical latitudes, we should possess data to determine whether or not the alterations in the magnetic pole produced a change in climate, and also if such a connexion does exist between these phenomena.

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* The discovery of the intimate connexion which subsists between the aurora and magnetism, was demonstrated by Dr. Dalton as early as towards the end of the last century, so that the remark of Hansteen must be considered only as a confirmation of the fact ascertained by the English philosopher.—Edit.

It is remarkable that in 1825, although Hansteen had previously paid great attention to the subject of the earth's magnetic intensity, he had no knowledge of a system further than that the intensity is greater at the poles than at the equator. In 1830, he sketched out the system upon a small part of the earth's surface, and in the same year completed his chart so far as observations allowed. Such is the consequence of the combination of men of power and cultivators of science.

Article XII.

ANALYSES OF BOOKS.

Traité experimental de Electricite, et du Magnetisme, et de leurs rapports avec les Phenomenes Naturels. Par M. Becquerel, tom. i. Paris, 1834.

This is an interesting work, and forms a concise digest of the facts which have been ascertained in the important branch of science of which it treats.

The author divides the work into two parts. In the first division he considers the general properties of the electric principle in rest and motion, as well as those relating to magnetism. In the second, he treats of their relations with chemical affinity, and their application to phospherescence, to spontaneous actions and other phenomena, which seem to derive their origin from electricity. In the historical preface with which the work commences, three periods are specified as forming distinct eras in the science.

The first period begins with Thales, 600 years before the Christian era, the first individual as far as we can learn from history, who observed the power of attracting light bodies, which amber acquires when exposed to friction, and terminates with the great discovery of Galvani in 1790. The second period extends from this discovery (inclusive) to 1820, when Oersted demonstrated the intimate connexion subsisting between electricity and magnetism. The third period brings the history of electricity and magnetism down to the present day.

Passing over this division of the treatise, which we consider well worth perusal, we proceed to present a short outline of the applications of electricity to the explanation of natural phenomena.

Phosphoresence, according to the facts which have been ascertained in reference to it, is produced in particular bodies by: 1. Heat, as occurs in the diamond, when submitted to a considerable temperature, a fact observed by Boyle in 1663, and in anhydrous nitrate of lime, and likewise in fused muriate of lime. Many other bodies exhibit this phenomenon in these circumstances, as shells, sulphate of lime, caustic potash, soda, and chalk. 2. Percussion, as adularia when struck in such a manner as to form fissures in the internal substance chalk. 3. Friction. 4. Exposure to the light of the sun, as in diamonds which lose this property by calcination, tubes of glass, &c. 5. Compression, which excites a luminous appearance in all bodies, water especially when compressed in a tube with a piston exhibits this property, and also olive oil, alcohol, ether, acetic acid, sulphur, sulphate of magnesia, nitrate of potash, black oxide of manganese, mica vegetable charcoal, oxygen and common air. According to Pearsall, chlorophane which loses its phosphorescent property by heat, resumes this quality by exposing it to the action of a Leyden phial.

This phenomenon, which is familiarly illustrated during the exposure to heat of fluor spar in a dark situation, and in the putrefaction of fishes, admits of explanation on the principle that light accompanies the disengagement of electricity only when the latter possesses sufficient tension, and that it is owing either to the separation of the two electricities at the moment when they are disengaged, or to their action upon the surrounding bodies, in order to form a neutral fluid. When the two electricities separate by friction the chemical action of two bodies which are in contact, it is impossible to collect the two fluids unless the two bodies are not good conductors, because they are so rapidly reinstated, that the two surfaces cannot accumulate enough of electricity to procure for them, on account of the conducting power of the body, enough of tension to produce the luminous phenomena. Thus good conductors are not phosphorescent, but bad conductors are possessed peculiarly of the property of phosphorescence.

Heat in delating the ultimate particles of certain bodies, deprives them of their equilibrium, and produces electricity; but in some circumstances a change in the state of their aggregation is occasioned by the same agency, which is a very productive cause of electricity.

State of the globe at its formation.—This is delicate ground to speculate on. M. Becquerel's explanations do not appear to be suited to the object to which they refer, but on the contrary, are bold and even rash. For the sake, however, of giving some insight into the theories which are now emanating from chemical geology upon such an interesting topic, we shall proceed a little farther with the subject. Geologists in general consider that the sedimentary deposits whose layers are more or less inclined to the horizon, have been displaced by subterraneous agency, which has acted after their formation, and given to the different elevation on the globe particular characters. These causes having acted at different epochs, it is obvious that several classes of mountains have been elevated which are distinguished by the direction of their course. Von Buch has shewn that the soil of Germany may be divided into four systems, and Elie de Boumont has endeavoured to classify the successive elevation of the European mountain ranges by referring them to twelve epochs. In the Alps the secondary and tertiary beds are inclined, while in the Vosges and England all the formations superior to the coal are nearly horizontal, from which circumstance and others of a similar nature, Beaumont has obtained an argument of no small importance to his theory. The systems which he enumerates are: 1. of Westmoreland and Hundsruck. 2. Of Ballon (Vosges) and Boccage (Calvados.) 3. Of the North of England. 4. Of Pays-Bas and S. Wales. 5. Of the Rhine. 6. Of Thuringerwald, Bohmerwald and Morvan. 7. Of Mount Piles, Coté d' or and Erzgebrige. 8. Of Mount Viso. 9. Of the Pyrenees. 10. Of Corsica and Sardinia. 11. Of the E. Alps. 12. Of the principal chain of the Alps from Valais to Austria.

Gneiss and granite are the rocks which have disturbed the newer formations, and protrude through them in the form of peaks If we could determine in what state these important constituents of the globe existed in the internal part of the earth, and with what they were associated, a great step would be gained. Our author however has not waited for any accurate knowledge on this head, but in company with M. Ampere has proceeded to theorize.

He considers the earth to have been primitively in a gaseous state. By the radiation of the heat into the regions of space the temperature of this mass of elastic matter was gradually diminished, condensing the different bodies according to their refractoriness and density. The metals would be first deposited, and would form an immense bath in the centre, from which an enormous heat would emanate, to retard the condensation of the other vapours. The first nucleus would be formed of unoxidized metals, after which less fusible substances would be deposited, producing new compounds. Potassium and sodium, in consequence of their strong affinities for a number of bodies, are convenient substances for effecting powerful results in these successive changes. The temperature continuing to lower, oxygen, hydrogen, and non-metallic bodies would act upon each other, and give origin to water and acids, which would produce a multitude of combinations. The first re-action upon the alloys of potassium with the more combustible metals would be strong, and give rise to heat sufficient to volatilize again many of the condensed bodies. At this period, the saline and earthy bases would be formed, and the oxygen having been absorbed by a great number of bodies, much azote would remain, in consequence of its weak affinity for the bases. As the diminution of temperature always continued, the crust formed over the metallic bath would occupy less space, and give rise to contractions and elevations which would produce the mountains according to Beaumont's explanation. The waters he conceives which began at first to cover the earth's surface were strongly acidulated, and in filtering through fissures in the crust would be accumulated in cavities, from whence they would fall on the fused metals, and give rise to earthquakes and volcanoes. These actions being frequently renewed the crust of the earth would increase in thickness, and would allow liquids to pass with greater difficulty, and eruptions would then become less frequent, in consequence of the diminution of atmospheric temperature. Then began organized beings to appear in the form of monocotyledonous plants of colossal dimensions, flourishing in an atmosphere possessing a much greater proportion of carbonic acid than now exists in it, an idea which is strengthened by the circumstance of the contemporaneous limestone containing shells of molluscous animals.

In the last of the transition formations we meet with remains of zoophytes and molluscous animals, then fishes, reptiles, birds, and mammiferous animals. The air being purified, and the earth having acquired greater stability, man appeared to rule over the hitherto spiritless globe. The world being thus formed, disintegration of the elevated matter, by electric, chemical, and other agencies, affords an explanation of the newer deposits.

Volcanoes.—The products of Vesuvius are lava, sometimes granite, mica slate, sulphurous and muriatic acid gases, sometimes carbonic, rarely azote. In the fissures of the rocks are found common salt, sal ammoniac, chlorides of copper and iron, boric acid, sulphur, sulphuret of arsenic. The volcanoes of America emit gases, differing from those of Vesuvius; Talima affords vapour of water, carbonic acid gas, and sulphuretted hydrogen, as well as those of Puracé, Pastoé, and Tuqueres. Humboldt relates that a shower of fish was discharged by a Mexican volcano. The most plausible theory considers these phenomena to be connected with a communication existing between the seats of volcanoes and the waters of the ocean; for the epoch when these eruptions were common, was when the communication was more easy. Then was effected that great depression in the West of Asia, whose lowest level is the Caspian Sea, and Lake Aral, (50 to 30 toises below the surface of the ocean) which extends from Saratov to Orenburgh, and appears to have an intimate connexion with the elevation of Caucasus and Hindoukha. This bason or crater resembles Hipparchus, Archimedes and Ptolomy, on the surface of the Moon, which are thirty leagues in diameter.

Terrestrial Heat.—The facts with which we are at present acquainted tend to prove that every place on the surface of the globe has an invariable mean temperature. The mean temperature of the equator is between 81·5 and 82° 4, being modified by the great extent of the equatorial seas. The entrepid northern navigators have found a great difference, in the same latitude, between the temperatures on land and in the open sea. At Melville I$^{d.}$ the mean heat was —18° 5C., while in the open sea it was—8° 3. Calculating from these data, the temperature of the pole would be—25° or—30°.

It is remarkable that those places which are situated on the same isothermal line do not present the same vegetable productions. Hence, some have divided climates into constant, where the temperature is steady during the year, variable, and excessive, which comprehend those where the differences are very great. Cassini, in 1671, had remarked that under the Observatory of Paris, the temperature was steady during the whole year; and the observation has been confirmed, the heat being determined to be 11° 82 (53° F.) Cordier has inferred, from his researches on the temperature towards the interior of the earth, that below a particular point where the temperature is steady, the heat increases with the depth, to the amount of 1° for every 25 to 30 metres.

M. Fourier has demonstrated that the cooling of the globe, *if such a fact is admitted,* must be very slow, being less than $\frac{1}{57000}$ of a centigrade degree for a century; and he has drawn these consequences: 1. All the heat below a particular point where the temperature is steady, has been possessed by the earth from its commencement. 2. This heat is intense in the nucleus, and at a certain distance from the centre it begins to diminish by regular laws up to the steady point. 3. The internal equilibrium changes with time, and will continue to alter until the whole heat is dissipated, but this process is going on in an extremely tardy manner. 4. The heat derived from the interior cannot appreciably modify that of the surface.

Humboldt has observed that in Mexico the decrease of temperature is not proportional to the height; and Boussingault has found that in twenty-three years the sources of the Mariara have increased in temperature from 59° 3 C. to 64°; and those of Strincheras, from 90° 4 to 92° 2. The diurnal variation of the thermometer at the equator on the sea is 1° to 2°, while on the continent it is 5° to 6°. At the equator the ocean's surface is hotter than the air; but at the poles the reverse is the case.* Between the tropics, the heat diminishes with the depth; on the polar seas it diminishes as we descend.

Such are some of the principal circumstances bearing upon terrestrial heat with which we are at present acquainted.

The *formations of which the globe is composed* is the next subject which our author takes up, after speculating upon the method in which it was consolidated, applying known agents to the explanation of volcanic phenomena, and tracing out a sketch of the facts which have been ascertained in reference to terrestrial heat. He first notices alluvial deposits which are in process of formation, consisting of peat, marls, gravel, stalactities, pisolites, and travertines. He then passes to mineral waters or salt springs, which are so influential in bringing up from considerable depths soluble salts. In these are found carbonate of soda, borax, alum, deposited in the fissures of rocks, nitrate of soda as in Peru, nitrates of potash, lime and magnesia, as in Hungary, Ukraine, Podolia, &c.; sulphate of magnesia, sulphate and carbonate of lime. These substances seem to be deposited by the water when traversing fissures of rocks, and which action is more energetic in proportion to the increase of temperature. The quantity of salts brought by these means is much greater than one without consideration would infer. The Carlsbad water discharges annually 746,884 pounds of carbonate of soda, and 132,923 pounds of sulphate of soda, in addition to numerous other substances. Now, the operation of solution must be effected by the electro-chemical action of the thermal waters upon the rocks, at a greater or less distance from the earth's surface.

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* In lat. 2° 9′ N., long. 20° 38 W., I found the temperature of the Atlantic Ocean 79°5, that of the air being 79°; and in 2·20 S.L., 59° 5′ E.L. the thermometer stood in the air at 80°, and in the Indian Ocean at 88°6.—EDIT.

The origin of the ocean's saltness has attracted the attention of many, but little light has been hitherto thrown on this subject. It is, however, apparent that the quantity of saline matter varies on account of the proximity of rivers; thus, the Baltic and the Black Sea are weaker than the ocean, and still more so than the Mediterranean.

From Boussingault's observations, it appears that the temperature of hot springs diminishes with the height; and hence, he infers that they have their origin in the volcanic fires. He found that the mineral waters near volcanoes contained sulphuretted hydrogen and carbonic acid, the identical gases which were detected among the vapours emitted from their corresponding volcanoes. The carbonic acid he considers as the product of the calcination of carbonate of lime and soda, or of their re-action upon silicious or aluminous substances, and the sulphuretted hydrogen may derive its origin from the re-action of the vapour of water upon sulphuret of sodium.

The rocks of the tertiary formations are in general calcareous and silicious with a predominance of magnesia, especially where the gypsum appears. Under this head are included the new formations characterized so happily by Mr. Lyell, and to whose work it is proper to refer the reader for accurate and interesting information.

The secondary rocks include the chalk, which is the result of chemical precipitation, the oolites, a sedimentary group, as well as the muschelkalk and zechstein.

In the transition rocks, the coal, according to Deluc, has been formed at a slight elevation above the sea like turf, and has been submerged and covered by the sand of the ocean. If these waters are supposed to have borne along with them earthy matter of an elevated temperature, an explanation will be afforded for the absence of animals in these rocks. The water under which the coal was formed must have possessed the property of holding iron in solution, as is apparent from the quantity of iron-stone which usually accompanies coal. Hence, the atmospheric pressure may have been greater.

The formations which derive their origin from the greatest depths, are obviously granite, mica slate, and the rocks usually termed primary. The porphyries, euphotides, or compounds of jade and diallage, serpentines, black porphyry, or ophites and dolomites, are more variable in their position.

Among volcanic products the trachites are considered most ancient, and are sometimes stratified. The traps, or basalts afford many minerals; the lava group contain also many species. Both Ætna and Vesuvius have been known to eject granite, in addition to the pulverulent and solid matter which they continue to emit at intervals.

Decomposition of Rocks—Veins.—According to Becquerel, veins are not to be considered as products of one general cause, but of a concurrence of several causes. The veins in the most ancient rocks are smaller than in the newer rocks, the largest existing in the schists and transition limestones. Werner considered that rocks were decomposed by two acids: 1. By carbonic acid as when granite and gneiss or felspar alone are decomposed and form kaolin. 2. Sulphuric acid derived from pyrites, as in veins of felspar, mica, and amphibole. Arsenic acid he considered produced a similar effect.

M. Fournet, who has paid much attention to veins, distinguishes two kinds: those of igneous origin, such as porphyries, trachites, &c. in which the silica has formed combinations by means of heat; and those of aqueous origin, as we see illustrated in mineral waters. To exemplify the former, he cites those instances where sulphuret of iron, silica, and iron pyrites have been deposited upon the fragments of primitive rocks, and with regard to the latter, he mentions cases where talc and mica are changed into a grey substance, and granites where felspar is altered into kaolin, likewise talcose schists where steatite is isolated in veins. In the veins of Pont Gibaud, he observed four other epochs. At the second period new branches were formed, which were filled with secondary and tertiary products, especially quartz, but likewise sulphurets, which have formed alternating zones of pyrites, galena, and hyaline quartz in small crystals. A third period distinguishes a dilatation which disturbed the sources of the galena and introduced solutions of sulphate of barytes. At the fourth epoch, the incrusting power of these sources appears to have been enfeebled, when pyrites and minute veins of carbonates were deposited. The fifth epoch was contemporaneous with the basaltic eruptions. It is obvious, that for an explanation of the mode in which these veins are filled, we must have recourse to chemistry. Thus, hydrate of iron proceeds from the decomposition of pyrites; the powder of hydrous oxide is derived from the decomposition of the carbonate, galena is gradually converted into a black pulverulent substance, which gives birth to black and white carbonate. With regard to the formation of rock-salt, Dumas has observed that in one variety of it which decrepitated when placed in water, the cause was attributable to hydrogen which condensed in its cavities.

Granite.—Saussure attributed the decomposition of this rock to a corrosive juice which dissolved the gluten uniting all its parts. Vanquelin and Alluan traced the cause to disintegration of the rock, and the removal of the alkali in the felspar by water. But Berthier has shewn that silica as well as potash is removed, a silicate of potash disappearing and silicate of alumina remaining. Felspar is probably one of those bodies whose particles are placed in such intimate union that acids have no effect upon it until it be exposed to electro-chemical agency. Fournet has observed three preliminary stages in the decomposition of granite. 1. A superior zone of a red or yellow colour, indicating the peroxidation of iron. 2. A middle zone of a deep green colour. 3. An inferior zone, presenting all the characters of a perfect granite, but falling to pieces when touched. He accounts for the successive decomposition from the surface, internally to dimorphism, which has changed their crystalline texture like arragonites and laumonites. Gustav. Rose has produced pyroxene and amphibole as instances of this dimorphism, of which some result from rapid, others from slow cooling. The theory of the felspar decomposition Fournet sums up shortly. The iron is peroxidized, carbonic acid is absorbed and takes the place of the silica, which, being set at liberty in a gelatinous state, dissolves in water, or alkaline carbonates, and gives origin to crystals of hyaline quartz, iorites, agates, opal, calcedony, and silicates, as chabasite, mesotype.

This theory, however, rests upon two suppositions which have not yet been demonstrated. 1. That igneous rocks do not acquire a state of permanent equilibrium, and that they exhibit in the course of time an effect of dimorphism, and 2. that carbonic acid is absorbed by these rocks. The latter appears to be strongly exhibited in Auvergne, where numerous mineral springs, which escape from granite fissures, act upon the rocks, and form small irregular basons which they fill with hydrous peroxide of iron.

Sparry iron ore.—Granite before it decomposes disintegrates, but the iron ore retains its form, and yet changes its chemical nature. Becquerel has examined the process of the decomposition of this mineral in Isere, and he has found it entire when preserved from the contact of air and water. In Dauphine it is decomposed in such a manner as to give out heat and light, which burst into flame and continue to burn. The inhabitants regard the presence of these flames as a decided proof of the existence of rich mines of this mineral. The mineral contains carbonate of manganese and magnesia. The iron and manganese change into hydrates, lose their carbonic acid which combines with the magnesia, and renders it soluble in water. Water is decomposed to afford oxygen to the hydrate, and the hydrogen inflames after overcoming an immense pressure.

According to Chapert, when some of the minerals accompanying this iron ore are roasted, and left to spontaneous action, after some days, sulphate of magnesia and iron, and carbonate of copper appear, facts of great importance in electro-chemistry. Four kinds of pyrites accompany this ore, which give origin, to 1. Neutral sulphate of iron. 2. Earthy sulphate, a yellow substance, resinous or earthy. 3. Ochre proceeding from the action of air upon the neutral sulphate; besides, sulphate of iron and alumina, manganese, lime, zinc, &c.

Lavas.—Granite decomposes readily in contact with bay-salt, as is evinced in Scotland and Clermont. The facility of the decomposition of lavas varies with their composition; thus the pyroxenic rocks of Auvergne decay more rapidly than the Labradore masses of

Como. Wacké is a rock formed by the action of water upon these rocks, and contains calcareous spar, zeolites and piperine.

There is reason to think that the crystals which are found in bay-salts, have been deposited after the consolidation of the rocks in which they are found, because most of them are altered by a strong heat, and lose their water of crystallization. Fournet attributes the formation of zeolites to the transportation of the elements by water from the neighbouring rocks.

Organic matter.—The mode in which organic matter undergoes decomposition has not been much studied, but a few curious facts have been ascertained. Davy found the manuscripts of Herculaneum converted into a kind of turf, the leaves being united into a single mass by a peculiar substance, formed by the chemical changes of the vegetable matter. The *guano* in Peru is found in deposits of 50 or 60 feet deep, and is formed of the excrement of herons which inhabit the coast.

Necker de Saussure has observed the teeth of the *ursus spilæus* in the mines of Carmiola, corroded as if by an acid. Turpin has noticed the egg of the garden snail to be covered on the interior surface of its envelope, with rhombohedral crystals of carbonate of lime. The cellular tissue of the cactus, and the medullary tissue of palms contain oxalate of lime in crystals.

Nitrification.—When distilled water is placed over plates of iron, lead, zinc, or tin, ammonia is formed in consequence of the combination of the hydrogen of the water with the azote of the air.

Vanquelin found ammonia in some rusty spots on a sabre, which had been employed by an assassin, and that other traces presented the same substance. Protoxide of iron, yenite, earthy oxide of iron heated in a tube, give out ammonia. Ammonia was detected in the ferruginous water of Passy after evaporation. Boussingault has observed it likewise in oxidized iron by taking a fragment of it, treating it with dilute muriatic acid, evaporating the washings, and heating the residue with quick-lime in a tube, using the precaution to moisten them with water. Faraday obtained ammonia, by heating zinc foil in a glass tube with potash. The experiment succeeded even in hydrogen gas. Potassium, iron, tin, lead, and arsenic likewise afford much of it, with soda, lime, barytes or potash. The alkalies alone do not yield it.

The formation of saltpetre has long been a subject of interest. Dumas conceives that the presence of organic matter is not essential. Claubry attributes its production to the action of an acid moisture upon carbonate of lime.

Fournet thinks that nitric acid may be formed without the presence of organic matter, by the re-action alone of the elements of air and vapour of water. For according to Saussure, oxygen is more condensable by porous bodies than azote, in the proportion of 6'5 to 4'00; and Gay Lussac and Humboldt have observed that air disengaged from water by boiling, contains more oxygen in proportion to the slowness of its extrication. The result is that oxygen is not only retained with a greater power, but the composition of the last portions of the air approaches protoxide of azote. Fournet has concluded, that the united action of porous bodies and of water upon the elements of air, would produce at first, protoxide of azote; then nitrate of ammonia, which when decomposed, resolves itself into protoxide of azote and vapour of water. The nitrate acts upon the alkaline carbonates and forms nitrate of potash, while the ammonia is disengaged in union with carbonic acid. He applies his theory to explain the production of nitrate of ammonia, dissolved in rain by the electric agency. He concludes by observing, that in every electric chemical action, however feeble it may be, if water is decomposed in contact with air, ammonia is formed.

Last geological revolution.—Becquerel endeavours to calculate this period, by a method which it must be allowed is extremely vague. He finds that the cathedral of Limoges, which has stood for four centuries, and is built of granite, is decomposed on that side where the winds and the rain beat to the depth of 3½ lines, and that the rock in situ is disintegrated to the depth of 5 feet or 720 lines. If both have progressed at the same rate, he conceives that the rock in its natural place must have been decomposing for above 82,000 years.

Terrestrial magnetism.—From the facts which have been brought forward by Humboldt and others, it appears proper, that experiments should be made upon the magnetism of the rocks, which constitute the formations of the country in which the experimenter is placed, or at least to determine at what point the extent of oscillations diminishes without changing their number.

Atmospheric electricity.—Saussure has shewn that in summer the electricity of the calm air is much weaker than in winter; and that the apparent force of electricity, depends not so much on the absolute height of the place of observation as upon the relative height, or on the insulation of the place. Disseminated as this principle is through the medium of the vapour of water, it is highly probable that it exercises no inconsiderable effect on the plants and animals which are of necessity subjected to its influence.

Becquerel terminates the first volume of his work, with some remarks upon the agencies by which the decomposition of some rocks and the formation of some insoluble compounds may be explained, which comprehends a recapitulation of some points. But he shews more particularly, how electro-chemical action operates in producing many minerals. Phosphate of iron in mines and crevices he considers to be the result of the action of electricity, which is disengaged during the peroxidation of iron and the decomposition of organic matter. The formation of the chromate of lead as it exists native, may be imitated by treating a solution of nitrate of lead with chalk and then with chromate of potash. In the course of a month or two, crystals of chromate of lead were observed on the surface of the chalk. By mixing sub-nitrate of copper, with arseniate of copper, a double arseniate of copper and ammonia, and of arseniate of lime and ammonia is formed. The re-action of bi-carbonate of soda upon gypsum gives origin to carbonate of lime which crystallizes, sulphate of soda remaining in solution.

A supplementary chapter is appended, containing a short outline of the interesting electro-chemical researches of Dr. Faraday.

ARTICLE XIII.

SCIENTIFIC INTELLIGENCE, &c.

I.—*Method of destroying Mice &c., in their lurking places.* (*Ann. de Chim.* xlix. 437.)

M. THENARD, in 1832, submitted to the Academy of Sciences a plan for destroying noxious animals, when they have taken refuge in their hiding places. The instrument of destruction is sulphuretted hydrogen, which he had remarked to be peculiarly deleterious to animal life. Animals when allowed to breathe the pure gas fall down as if struck with a bullet. Even when considerably diluted with atmospheric air, the effects are deadly. A horse dies in less than a minute, in air containing $\frac{1}{250}$ of this gas. A dog of moderate size is speedily killed in air containing $\frac{1}{1000}$ while a greenfinch expires in a few seconds in air possessing $\frac{1}{1500}$ of sulphuretted hydrogen. Influenced by these facts, the French chemist proposed the employment of this gas to several individuals for the purpose of extirpating noxious vermin, but his suggestions being treated with indifference, he determined to put the method in practice by his own experiments.

His first trial was in an apartment infested by rats, which shewed themselves occasionally during the day, and at night were actively engaged in plundering a chest of oats, to which they had access through an aperture of their own formation. The holes by which they retreated amounting to 18 in number, Thenard adapted to each of them in succession retorts capable of containing half a pint measure, by introducing the beak of the retort and filling up the interval round its neck with plaster. Sulphuret of iron was deposited in the retort, formed from a mixture of iron filings sulphur and water, and dilute sulphuric acid was introduced by means of a tube placed in the tubulure. The sulphuretted hydrogen was disengaged with great rapidity, and in a few minutes not a rat remained alive in the building. His next experiment was in an old abbey where he was equally successful, and having opened up part of the wall he found many dead rats. He recommends the application of this method to the destruction of moles, foxes, and all animals which cannot be extirpated by the usual means. Thenard then gives popular directions for the formation of the materials required to produce the gas.

Mix 4 parts of iron filings, 3 parts flowers of sulphur in a mortar with a pestle. Place the mixture in a convenient vessel, and moisten it with 4 parts of boiling water, stirring it with a piece of wood or glass. Add gradually afterwards 4 parts more of water, and introduce it into the retort. Pour upon the mixture common oil of vitriol diluted with five times its volume of water, and continue to add it gradually till the effervescence ceases. Should any of the gas escape into the apartment and occasion inconvenience, it may be removed by dropping a little sulphuric acid upon bleaching powder. The holes should be closed immediately, to prevent the disagreeable effects of the putrefaction of the carcases of the animals which have thus been destroyed.

II.—*Fresh Water formation in Greece with Lignites.* By M. Theodore Virlet. (*Annales des Sciences Naturelles*, tom. xxx. 160.)

In 1830 a report was very generally spread of the discovery of coal in Greece. M. Theodore Virlet, who was in that country soon after the coal was said to have been observed, proceeded to the spot for the purpose of examining into the truth of the report. He visited the *Sporades Septentrionales* or Devil's Archipelago, situated at the mouth of the Gulfs of Volo and Salonica, near the coasts of Thessaly and Macedonia, where it was said coal existed. He found the islands of Skiathos, Skanzoura, and Diodelphia to consist of primitive rocks, those of Xero, Xera, Panagia, Jaoura, Piperi, &c. to belong to a calcareous formation. In the island of Skopelos the latter rests on clay slate, and in some respects agrees with the transition limestone, but the existence of a number of fossils and especially *Hippurites semicostellata*, proves its distinct nature. *Tornatella prisca, and Turritella antiqua* Desh are likewise met with.

Iliodroma is a long, narrow, mountainous island which consists of three formations: 1. Mica-slate, clay-slate and limestone. 2. Blue and grey limestone. 3. A fresh water tertiary formation containing lignites which occupies half of the surface of the island, and was mistaken for coal. The lower portion is situated 200 or 300 metres above the sea, and is constituted of blue or green marls with a great deposit of fresh water and land shells belonging chiefly to the genera *Planorbis, Paludina, Helix*. Over these marls lie thin strata of marly limestone without fossils, but containing an irregular bed about 2 feet (Paris) thick of lignite, in general mixed with clay and shells. Above the lignite grey marls occur, filled with the debris of fossil vegetables. The whole of the formation is about 190 English feet in thickness. Among the fossils obtained from this formation, the most numerous belonged to what M. Adolphe Brongniart who examined it, has termed *Taxodium Europæum*. It has also been found at Comothau in Bohemia, and at Œningen near the lake of Constance. It belongs to the order Corniferæ, and is characterized by long slender branches, subglobose cones, with leaves spiral or sometimes arranged in three rows.

Virlet considers this formation more ancient than that of Œningen, and contemporaneous with the dislocation of strata which produced the Dardanelles, and with the corresponding formation in Switzerland, and the marine deposit of *Gompholites* in the Morea.

III.—*Oil extracted from the Spirit of Wine of Potatoes.* By M. J. Dumas. (*Ann. de Chimie*, lvi. 314.)

Previous to rectification, spirit of wine whether it be obtained from malt or potatoes, possesses a peculiar taste and smell which is removed by distillation frequently repeated. It has been long known that these properties depend on a peculiar oil, and its presence was first detected by Scheele. Fourcroy and Vauquelin proved that the oil was not a product of fermentation, but that it existed in grain and could be separated by treating it with water, and taking up the oil from the liquid by alcohol. M. Payen has shewn that the seat of this oil is in the tegumentary part of the fecula of potatoes. Those who have examined the oil proceeding from the spirit of barley, describe it as capable of crystallization, volatilizing with difficulty, undergoing alterations by distillation, and staining paper permanently. Pelletan found on the contrary, the oil from the spirit of potatoes to be a true essential oil. Dumas examined a specimen from the manufactory of Dubrunfaut; it possessed a reddish yellow colour, and a very disagreeable smell. When one breathes the air charged with it, nausea and head-ache are produced. Carbonate of potash diminishes the odour considerably, and when distilled with it renders it analogous to that of nitric ether. In order to free it entirely from alcohol, it is necessary to distil cautiously, and obtain a residue of pure oil boiling at 130° (266° F.) or 132° (269°) the alcohol passing over first. Dumas suggests that although bearing some affinity to alcohol and ether, it may belong to the family of camphors. The density of its vapour is 3·147, or calculating from the composition 3·072. It consists of:—

Carbon	68·6
Hydrogen . . .	13·6
Oxygen	17·8

IV.—*Mode of Detecting some Organic Acids.* By H. ROSE, (*Poggendorff's Annalen.* xxxi.)

TARTARIC, racemic, citric, and malic acids may be readily detected in the following manner: dissolve them in as small a quantity of water as possible, and add to the solution an excess of lime water, so that reddened litmus paper may become blue.

Tartaric and racemic acids form a precipitate in the cold state. That produced by the tartaric acid dissolves completely in a small quantity of a solution of ammonia, while that of the racemic acid remains insoluble. Both acids can likewise be readily distinguished by their treatment with a solution of sulphate of lime, when after some time racemate of lime is deposited, while the solution of tartaric acid is not affected.

The solution of citric acid yields no precipitate with lime water in the cold state, but when heated, a considerable precipitation occurs. If a small quantity of a very dilute solution of citric acid is mixed with lime water, a precipitate falls by boiling, which is taken up by allowing the solution to cool. The solution of malic acid occasions no precipitate with lime water, either in the cold or by boiling. For these experiments completely saturated lime water should be employed.

V.—*Iron Mine of Rancié.* By M. DUFRENOY. (*Ann. des Sciences Naturelles,* xxx. 59.)

THE formation of Vic Dessos, consisting of a compound of white saccharoid limestone, black compact limestone, shistose limestone, belongs to the inferior portion of the Jura formations.

The Hematite of Rancié contained in this deposit, is disposed in layers, and is connected with the granite at a little distance from the mine, and has been introduced into the lias formation at the period of the upheaving of the Pyrenean granite. The saccharoid limestone of the Valley of Sue owes its texture to its position in contact with the granite.

The limestone contains *Pecten equivalvis ; Terebratulae and Belemnites.*

VI.—*Geological position of the Campan Marble.* By M. Dufrenoy. *(Ann. des Sciences,* xxviii.)

This marble forms a subordinate bed in the transition formation of the Pyrenees. It consists of nodules of limestone, agglutinated with clay slate of a greenish or reddish colour, presenting an amygdaloid appearance. The nodules are *Nautili*, of which the spiral form may frequently be detected. Dufrenoy considers the formation contemporaneous with that of Plymouth. Near the village of Sirach, in the Valley of Prades, besides *Nautili,* several fossils peculiar to the transition formation appear. Prades is situated on granite. Over the granite, clay-slate reposes containing felspar veins and red oxide of iron. This slate is green, passes insensibly into a mixture of limestone, and then into the marble. In the limestone which succeeds are formed *Orthoceratites, Terebratulae,* and *Encrinites,* similar to those of Dudley.

It is remarkable that the strata which contain the *nautili* are at a distance from the granite, and that in proportion as we approach this rock, the nodules loose their organized character. At a little distance at Tuchan, slates resembling those of Sirach occur covered by the coal formation, where impressions of vegetables appear abundantly. The coal is worked at Segur and Quintillan.

VII.—*Effect of Gases on Vegetation.* By M. Macaire. *(Ann. des Sciences Naturelles.)*

M. Macaire introduced some plants of Euphorbia, Mercurialis, Senecio, Sonchus &c. into vessels along with chloride of lime in the morning. When evening arrived the plants had not suffered, and the odour of the chlorine was as strong as at first. Next morning they were found withered, the smell of chlorine had disappeared, and was replaced by a very disagreable acid odour. The same result was obtained on repeating the experiment several times.

Nitric acid withered the plants during the night, but in the day time merely rendered some of them brown coloured.

Sulphurretted hydrogen produced no alteration when light was present, but destroyed them in the night, by the absorption of the gas.

Muriatic acid gas acted in a similar manner.

VIII.—*Notices of the Natural History of Egypt in* 1832. By M. Roux. *(Ann. des Scien. Nat.)*

The only species of *Helix* which he found was the *irregularis,* in the vicinity of Alexandria. He discovered two new species of

Salicoques, in the Nile which he termed ***Palaemon Niloticu*** and ***Pelias Niloticus.***

M^{t} Mokatan, in the neighbourhood of Cairo, consists essentially of a limestone with nummulites, affording fine specimens of a species belonging to the genus Xantho. Egypt is well supplied with birds of prey, and contains most of those found in France. M. Roux saw a *Fringilla* approaching the *Cisalpina* of Temminck. In Fayoum he noticed flocks of pelicans to the amount of thousands, which produced a noise resembling the discharge of musketry when they struck the water with their wings in attempting to rise. They appear easily capable of being domesticated. Mr. Hey an Englishman, possessed one which used to fly to the marshes adjoining the Nile for the purpose of procuring food, but returned regularly to the canja of its master.

Immense flocks of *Anas Cinereus*, *segetum and albifrons,* and perhaps also *erythropus,* may be observed in the morning and evening; the *egypticus* is found principally in the rocks of the Arabian chain. M. Roux found a new insect belonging to Aptera hexapodes among the sands at Giseh, which he terms *Necrophylus arenarius,* The birds embalmed were *Neophron permopterus,* a species of *falco.* (faucon crassarelle,) *Sparvius palumbarius, Ibis fascinellus.* At Saccarah he never noticed *Ibis sacer.*

IX.—*Summary of a Meteorological Register kept at Eccles,* Berwickshire.* By the REV. JAMES THOMSON.

	Barometer.	Thermometer.
December 1833 . . .	28·960	43°·6
January 1834	29·411	38°·5
February	—·570	40°·1
March	—·531	45°·4
April	—·765	46°·8
May	—·624	55°·2
June	—·526	60°·4
July	—·586	60°·8
August	—·444	62°·2
September	—·594	55°·0
October	—·482	49°·9
November	—·510	43°·5
Mean for 1834	29·500	50°·11
" 1833	29·257	
" 1832	29·523	
Mean for three years . . .	29·426	

* Eccles is situated in about 55° 40′ N. L.

ERRATA.—Page 44, line 21.—The quantity of oxide here given is what is contained in 100 grains of the mineral.

Page 70 last line, for 88°·6 *read* 80°·5.

JANUARY 1, 1835.

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Conducted by Robert D. Thomson, M.D., with the assistance of Thomas Thomson, M.D., F.R.S., L. & E., &c., Regius Professor of Chemistry in the University of Glasgow.

Contents.

On Calico Printing, illustrated by actual Pieces of Calico; and New Experiments on Respiration, by Professor Thomson. On the Blood, by J. Andrews, Esq. On Vanadiate of Lead, by R. D. Thomson, M.D. Experiments on the Blood, by Hermann, Gmelin, and Tiedemann. New Substances discovered in Coal Tar, of great interest to Manufacturers, by Runge. A Journey in Spain, by M. De Le Play. Analysis of Becquerel's Electricity, &c. &c.

X.

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RECORDS

OF

GENERAL SCIENCE.

FEBRUARY, 1835.

Article I.

Biographical Account of Alexander Volta. By M. Arago. *(Abridged from the Ann. de Chimie,* vol. liv.*)*

Amber it was remarked, as early as the times of Theophrastus and Pliny, possesses the remarkable property of attracting light bodies, such as feathers, after it has been smartly rubbed. The name of the substance *(electron)* came to be applied to this property, which it acquired by friction. For a long period electricity was confined to narrow limits, but to Volta was left the developement of the brilliant science which has succeeded the discovery of the principle, for he found electricity by the aid of peculiar apparatus every where; in combustion, in evaporation, in the simple approximation of dissimilar bodies; and thus assigned to this powerful agent an immense field among terrestrial phenomena, which yields only to that of gravity.

Alexander Volta, one of the eight foreign associates of the Academy of Sciences, son of Philip Volta, and Magdalene de Conti Inzaghi, was born at Como, in the territory of Milan, on the 14th February 1745. He was educated under his father's eye, in the public school of his native city, and from his talents and indefatigable application, speedily surpassed his school-fellows. At ten years of age he composed a Latin poem descriptive of the phenomena observed by the most celebrated experimenters of the day, which has never however been published, and afterwards he wrote some verses on Saussure's ascent to the summit of Mont Blanc.

At eighteen years of age he corresponded with Nollet, upon some of the most delicate questions in physics.

When twenty-four, he broached the subject of the Leyden phial in his first Memoir. This apparatus was discovered in 1746. Its singular effects were sufficient to justify the curiosity which it excited over all Europe; but this excitement was in a great measure increased by the foolish exaggeration of Muschenbröek, who on receiving a feeble charge, was affected with such extraordinary fear, that he exclaimed emphatically, that he would not undergo a second shock for the finest kingdom in the universe. To Franklin is due the honour of having explained the mode of action of the Leyden phial.

The second Memoir of Volta appeared in the year 1771, in which we find no idea of system. Observation is the author's only guide in endeavouring to determine the electricity of bodies, and in assigning the temperature, colour, and elasticity, which produce variations of the phenomena, and in studying the cause of the production of electricity, whether by percussion, friction, or pressure.

In Italy these Memoirs produced a strong sensation, and their author was elevated to the situation of Regent of the Royal School of Como, and soon afterwards was made professor of physics.

The missionaries at Pekin, in the year 1775, communicated to the philosophers of Europe the important fact which they had accidentally observed, that electricity shows itself or disappears in certain bodies, when they are separated, or in immediate contact. This fact originated the interesting researches of Æpinus, Wilcke, Cigna, and Beccaria. Volta also made it his particular study, and drew from it his idea of the perpetual electrophorus, an admirable instrument which, in the smallest size, forms a source of the electric fluid.

To his memoir upon the electrophorus, succeeded in 1778 another very important work. It had been already observed that a given body, whether empty or full, possesses the electrical capacity, provided the surface remains constant. The experiments of Volta, however, shewed that of two cylinders, possessing the same surface, the longest receives the greatest charge, so that an immense advantage is gained by substituting for the large conductors of common machines, a system of very small cylinders, although on the whole, these do not occupy a greater bulk. In combining for example, sixteen wires of thin plated rods, each 1000 feet in length, according to Volta a machine would be produced whose sparks would kill the largest animal.

None of Volta's discoveries were fortuitous. All the instruments with which he enriched science were fairly planned out in his imagination before the artist was employed to construct them.

In 1776 and 1777, the professor of Como was occupied with purely chemical subjects. At this time chemists considered that inflammable gas was a product of coal and salt mines only, but Volta proved that the putrifaction of animal and vegetable substances is always accompanied with the disengagement of inflammable gas, and that if we stir the bottom of stagnant pools, the gas escapes, producing all the appearances of ebullition. Thus, the carburetted hydrogen of marshes was first discovered by Volta.

He ascribed burning mountains and formations to the same cause; and in 1780, visiting Pietra Mala de Velleja, he proved that the phenomenon so celebrated at that place was owing, not to petroleum or naphtha, but to carburetted hydrogen. The electric spark was used to set fire to certain liquids, vapours, and gases, such as alcohol, the smoke of a newly extinguished candle, and hydrogen, but all these experiments were made in the open air. Volta was the first who repeated them in close vessels, in 1777, and to him therefore, is to be ascribed the idea of the apparatus in which, in 1781, Cavendish synthetically formed water by combining the two constituent gases by means of the electric spark.

Volta never abandoned a subject until he had considered it in all its branches, uniting in a remarkable manner, the unusual combination of an inventive genius, and the spirit of application. Thus, in his researches upon inflammable gas, he discovered the electrical gun and pistol, then the permanent hydrogen lamp, so well known in Germany, which lights itself by the most ingenious application of the electrophorus; and lastly, the eudiometer, which is still an indispensible instrument in the analysis of gases, and has enabled us to ascertain, that notwithstanding the immense consumption of oxygen by men, quadrupeds, and birds, in the act of respiration, and its necessary support of combustion, whether we examine atmospheric air in the scorching equitorial regions, over the immensity of the ocean, the elevated plains of Asia or America, the snowy summits of the Cordillera or Himmalays, the proportion of oxygen remains constant. Humboldt, Gay Lussac, and others, have investigated the accuracy of different eudiometers, and have found that Volta's is by far the most accurate. In connexion with this subject, although not in chronological order, may be mentioned the experiments which he published in 1793, upon the dilatation of air.

This question had attracted the attention of philosophers, the results of whose experiments were very discordant. Volta discovered the cause of these differences and shewed, that in experimenting in a vessel containing water, we ought to find increasing dilatations; that, if there is not in the apparatus any moisture but what usually covers the glass, the apparent dilatation of the air may be increasing in the lower part of the thermometric scale, and decreasing in the upper part; he proved by delicate experiments, that atmospheric air, if it is contained in a vessel perfectly dry, dilates in proportion to its temperature, that is, the elasticity of a given volume of atmospheric air is proportional to its temperature.

When we heat air taken at a lower temperature, containing always the same quantity of moisture, its elastic force increases like that of dry air. Hence, Volta concluded that the vapour of water and air, properly speaking, dilate in the same way, which is now known to be correct. Our knowledge upon this subject is, by the labours of Gay Lussac and Dalton, now complete. They made their experiments before those of the Italian philosopher were known either in England or France.

We come now to the researches of Volta upon the electricity of the atmosphere; but before considering them, it is proper to attend to the knowledge which had been previously acquired in this department. Dr. Wall, who wrote in 1708, offers the ingenious observation that the light and crackling of electrified bodies appear to a certain extent, to represent lightning and thunder.

Stephen Grey, in 1735, observed that in time it is probable means will be found of concentrating great quantities of electrical matter, and of increasing the power of an agent, which appeared to him, if small things can be compared with great, to be of the same nature as thunder and lightning.

Nollet, in 1746, gave it as his opinion that thunder, in the hands of nature, is electricity in the hands of natural philosophers.

The first views of Franklin, like those of his predecessors, were simple conjectures; but the former did not rest satisfied with conjecture; he proposed to bring it to the test of experiment, by observing if a pointed metallic rod would afford sparks, during a thunder storm, similar to those of the electrical machine. Without wishing to tarnish the glory of Franklin, it may be remarked that the proposed experiment was unnecessary. For the soldiers of the Fifth Roman Legion had already made it during the African war, on the day when, as Cæsar tells us, the iron of their javelins appeared on fire; and in Friol at the chateau of Duino, the overseer did what Franklin desired, when conformably to his orders, with the view of protecting the fruits on the approach of a storm, he ascertained with an iron instrument, if sparks could be obtained from a rod placed vertically. On the 18th May 1752, D'alibard during a storm, procured small sparks from a pointed piece of metal which he had placed in his garden, which was a month previous to the results obtained by Franklin with his kite.

The introduction of thunder rods was the consequence of Franklin's discovery. It is curious to look into some of the writings of that period. In one place you find travellers braving the storms with sword in hand, in the attitude of Ajax menacing the heavens; in another, the clergy, to whom custom has interdicted the sword, regretting bitterly that they were deprived of this precious talisman. Some philosophers did not admit the utility of these instruments.

They granted the identity of lightning and the electric fluid, the experiment of Marly la Ville having decided the point; but the small number of sparks which proceeded from the rod made them doubt the possibility of extricating the immense quantity of matter contained in a cloud. Even the dangerous experiments of Romas de Nerac did not satisfy them; but the melancholy death of Richman, on the 6th August 1753, by the electric fluid which was conducted by the string of a kite which he was raising, convinced them of the fact, and enabled them they conceived to explain a passage in Pliny, where the naturalist relates that Tullus Hostilius was killed by lightning for having been irregular in the performance of ceremonies, in consequence of his predecessor Numa causing thunder to descend from heaven. Subsequently, disputes occurred with regard to the propriety of using thunder-rods with sharp points or with nobs.* Lemonnier, in 1752, discovered that electricity existed in the atmosphere, not only during storms, but when the sky was perfectly clear. He observed also, that in clear weather it underwent regular variations of intensity; and Beccaria established the fact that in all seasons, at all heights, and during all winds, the electricity in clear weather is constantly positive or vitreous.

For a considerable period after the Leyden phial had been discovered, the electrometer was not thought of. Darey and Le Roy, in 1749, invented one, and in 1752 Nollet proposed an instrument consisting of two threads, which, after being electrified by the effect of repulsion, separated like the legs of a pair of compasses.

Cavallo, in 1780, realized what Nollet had only projected. His threads were of metal, and bore at their extremities spheres formed of the pith of the elder. Volta substituted for the pith dried straws. His letter to Lichtenberg in 1786, in which he established, by numerous experiments, the properties of electrometers formed with straws, contains a description of the method by which these instruments may be compared; of the intensity of the greatest charges, and of certain combinations of the electrometer and condenser. This letter is well worthy the attention of young philosophers.

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* I have omitted in the text to mention the observation of M. Arago, that the circumstance of George III. taking part with those who recommended rods with nobs, against Franklin, who advocated the use of pointed conductors, is to be considered an important incident in the history of the American Revolution.—Edit.

In 1785 Saussure increased the delicacy of the electrometer, by the simple addition of a stalk, eight or nine decimetres in length. And Volta in 1787, further added to its sensibility, by adapting to the metallic addition of Saussure a lighted candle, or even a match. He even suggested that, from the excellent electrical conducting power of flame, the best method of preventing the evil effects of thunder storms, would be to make large fires in the midst of plains, or on the summit of elevated places. His views have not hitherto been subjected to the test of experiment. Perhaps some light might be thrown on the subject by comparing the meterological observations of those localities where iron-works are established with the surrounding agricultural districts. The learned endeavoured, not from a wish to honour the dead, to show that his discovery had been anticipated by the ancients, and considered that the fabulous Greek fires were to be ascribed to this cause.

The hypothesis which had been formed that the electric phenomena are attributable to two fluids, naturally conducted to the investigation of the source from which they emanate. A simple experiment tended to solve the question. A vessel insulated where water was evaporating gave evident proofs of negative electricity.

It is not well known to whom the merit of this experiment is to be ascribed. Volta in one of his memoirs says, that he had thought of it in 1778, but that different circumstances having prevented him from executing it, he only succeeded at Paris in March 1780, in company with some members of the Academy of Sciences. On the other hand, Lavoisier and Laplace merely say that Volta wished to assist at their experiment, and to be useful to them. The cause of this difference in their statements is that Volta was present at the first experiment, which did not succeed, but was absent from the successful one. He, however, planned the means of discovery and the actual experiment, and is entitled to the credit of the success. According to him, when the insulated metallic vessel in which water is evaporating becomes electrical, the water, in order to pass into the gaseous state, imparts to the bodies which it touches, heat and electricity. The electrical fluid is therefore an essential part of the great masses of vapours which are daily formed at the expense of seas, lakes, and rivers. These vapours being condensed in the cold regions of the atmosphere, the electricity would accumulate, unless rain, snow, and hail enabled it to return to its proper source.

We arrive now at the important epoch when a new form of electricity was discovered. It is curious that the immortal invention of the galvanic pile owes its origin to a slight rheumatism with which a lady of Bologna was affected in 1790, and for which, a dish of frogs was prescribed by her physician. Some of these animals, deprived of their skins by the cook of Madame Galvani, lay on the table, when accidentally, an electrical machine was discharged. The muscles although they had not been touched by the sparks, were strongly contracted. Galvani, in varying his experiments upon this point, observed that similar contractions may be produced by interposing one or two plates of a metal between a muscle and nerve; and, following up his researches, he thought he had proved that positive electricity had its seat in the nerves; negative electricity in the muscles. These views seduced the public; electricity now took the place of the nervous fluid, which had long been a great favourite, although its existence no one had attempted to demonstrate, and it was thought that the physical agent had been at length obtained in an insulated state, which carries to the sensorium the external impressions; but alas! this romantic dream was dispelled by the rigid experiments of Volta, for he proved that contractions are produced by merely touching the muscle with two metals, and affirmed that electricity was the active agent in these contractions.

Although opposed on all hands, he continued stedfast in his opinions; and at present, when a splendid science has been erected on the discovery of Galvani, his deductions are found to be correct.

It was in the beginning of the year 1800 that Volta constructed the pile, the most wonderful instrument which human intelligence has ever created; for to it we owe some of the finest discoveries in chemical science; and with it must the name of Volta be handed down to succeeding generations.

Some of the biographers of Volta have accused him of enfeebled intellect during the last thirty years of his life, but this charge must be repelled, when we learn that he wrote two ingenious memoirs, the one upon the phenomenon of hail, and the other upon periódical storms, and the cold accompanying them, sixteen or seventeen years after the discovery of the pile.

The duties to which Volta had been bound almost from his infancy, retained him in his native city till 1777, when he left the picturesque banks of the lake of Como, and passed into Switzerland. At Berne he visited Haller, who, from the immoderate use of opium, was early sent to his grave.

At Geneva he formed a warm friendship with the historian of the Alps, who was well able to appreciate the value of his discoveries. That was a great age when the traveller, without losing sight of Jura, could visit Saussure, Haller, Jean Jacques, and Voltaire. Volta after an absence of a few weeks, returned into Italy by Aigue Belle, carrying with him, for the benefit of his country, that precious root whose proper cultivation renders famine impossible. He wrote an account of his journey, which was long buried in the archives of Lombardy, and was only published in 1827, by M. Antoine Reina of Milan, on his marriage, for in Italy every one in his own sphere, at this happy period, endeavours to confer some benefit on his countrymen. So remarkable are human institutions, that the fate of one of the greatest geniuses of which Italy can boast was at the mercy of the Administrator-General of Lombardy. Fortunately, Count Firmiali who occupied this station, was a friend of letters. The school of Pavia became the object of his attention. He then established a chair of physics, and in 1779, conferred it upon Volta. There Volta taught for many years numbers of young men who congregated from all parts of the country, not indeed, the mere details of science, which can be learned from books, but the philosophical history of the different discoveries, and those minute facts which escape vulgar intellects.

The language of Volta was lucid without preparation, sometimes animated, but always impressed with modesty and politeness. These qualities, when allied with merit of the first order, always make a deep impression upon youth; but in Italy, where the imagination is easily raised, they produced complete enthusiasm. Volta, like his countrymen, was a domestic person, and it is thought he never visited Naples or Rome. Certain it is that he never stirred from home except with scientific views. If in 1780 we find him crossing the Appenines from Bologna to Florence, it was for the purpose of investigating at Pietra Mala the nature of the inflammable gas. If in 1782, accompanied by the celebrated Scarpa, he visited the capitals of Germany, Holland, England, and France, it was to form an acquaintance with Lichtenberg, Van Marum, Priestly, Laplace, and Lavoisier, and to enrich the Cabinet of Pavia with philosophical instruments.

At the invitation of Bonaparte, Volta repaired to Paris in 1801, where he repeated his experiments upon electricity, before a numerous commission of the Institute. At the suggestion of the First Consul, they voted him a gold medal by acclamation; and, as Bonaparte did nothing by halves, on the same day Volta received from the funds of the State, 2000 crowns to defray the expenses of his journey. Bonaparte displayed his enthusiasm in the cause of this branch of the science, by establishing a prize of £2500 in favour of the individual who should make a discovery which could be compared with those made by Franklin and Volta, and further, conferred upon him the cross of the legion of honour and of the iron crown, named him Member of the Italian Council, and elevated him to the dignity of Count and Senator of the kingdom of Lombardy. Volta made no figure as a politician, falling short in this respect of Newton, who, during his parliamentary career, is said to have spoken only once in the House of Commons, and the solitary oration was to direct the doorkeeper to shut one of the windows through which a draft of air was directed upon the member who was addressing the house. Volta, however, never uttered a word.

He married in 1794 Theresa Peregrini, by whom he had three sons. Two of them have survived him; the other died at eighteen, when the brightest hopes were entertained of his talents. This misfortune is the only one which our philosopher may be said to have experienced during his long career. His discoveries no doubt created envy; but if, as Franklin says, happiness like material bodies, is made up of insensible elements, then was Volta happy. His difference of opinion with Galvani was no doubt unfortunate. Yet no Italian ever pronounced the name of Volta without profound esteem and respect; and, from Raveredo to Messina, he was hailed by the title of *our* Volta. Besides the distinctions conferred by Bonaparte, he was honoured by the different Academies in Europe. But these dignities never created pride in him. The little town of Como continued to be his favourite residence. The flattering and repeated offers of Russia could not prevail upon him to change the beautiful sky of Milan for the fogs of the Neva. Ambition or the love of money had no influence on him. The desire of study was the only passion he possessed, which preserved him pure from worldly connexions. A strong and quick intellect, extended and just ideas, and sincerity, were the characteristics of the illustrious professor.

Volta was tall, possessing handsome and regular features, like those of an ancient statue, with a large forehead, which profound thinking had deeply furrowed His manners retained some traces of the rural habits which he had acquired in his youth. Many persons remember having seen Volta when at Paris enter daily the bakers shops, and eat in the street large loaves which he had purchased, without supposing that any one would remark him. These minute circumstances with regard to great characters are interesting. Fontenelle has said of Newton that he had a thick head of hair, and that he lost only one tooth.

When Volta resigned in 1819 his situation in the University of Tesino, he retired to Como, and gave up all his connexions with the scientific world, scarcely admitting to an interview any of the numerous travellers who were attracted to the place by his renown. In 1823 an attack of apoplexy threatened severe symptoms, which were overcome by medicine. But in March 1827, the venerable old man was seized with a fever, which in a few days exhausted his remaining strength, and on the 5th of the month he expired, without pain, aged eighty-two years and fifteen days. It is remarkable that on the same day, and at the same hour, France lost the immortal author of the *Mecanique Celeste.*

The remains of Volta were carried to the tomb with great respect. The professors, the friends of science, the inhabitants of the town and neighbourhood, accompanied the body of this wise philosopher, of this virtuous father, of this charitable citizen, to its last home. The handsome monument which has been raised to his memory, near the picturesque village of Camnago, is a striking proof of the sincerity of their sorrow.

The place of Foreign Associate, which was left vacant by the death of Volta, was filled by Dr. Thomas Young. Scientific bodies are fortunate, when in recruiting, they can thus make genius succeed to genius.

Article II.

Chemical Analysis of Thulite. By Thomas Thomson, M. D., F. R. S., L. and E. &c.; Regius Professor of Chemistry in the University of Glasgow.

This mineral has been known for about twelve years; but I am not aware that any mineralogical description of it, or chemical analysis of it has been published, either in this country or on the continent. I got a specimen of it last summer, from Dr. Bondi of Dresden. It bears so striking a resemblance to bisilicate of manganese, that I had no doubt before examining it, that I would find its constitution similar to the composition of that mineral. The blow-pipe indicated merely a trace of manganese, so small that it was not worth while to attempt to separate it. But I found abundance of peroxide of cerium, which I did not expect. It contains also lime, potash, and peroxide of iron, all seemingly in combination with silica. It constitutes, therefore, a new and not uninteresting species of cerium minerals, hitherto rather few in number. I conceive, therefore, that a short account of its mineralogical characters, and of its chemical analysis, will be acceptable to the mineralogists and chemists of this country.

The locality of Thulite is Souland in Tellemark, Norway. The mass of my specimen is white granular quartz, through which the Thulite is disseminated. I am ignorant of the name of the individual who discovered and named it.

The colour is a fine rose-red, streak greyish, while my specimen exhibits the thulite only in grains of a greater or smaller size. But Mr. Brooke informs us that he found it to yield to mechanical division an oblique prism, with angles of 87° 30′ and 92° 30′. But he could perceive no distinct cleavage transverse to the axis of this prism.

Lustre vitreous; hardness about 6; but the grains separate from each other so easily that it is not easy to determine the hardness, translucent on the edges.

Specific gravity of my specimens 3·1055. Breithaupt states it at 3·124. This is a sufficient proof that thulite differs entirely from bisilicate of manganese, for the specific gravity of that mineral is 3·538.

Before the blow-pipe it fuses with carbonate of soda into a greenish white opaque globule. With borax it fuses into a colourless transparent bead, with a quantity of uncombined silica in the centre. If to this bead we add a little nitre, and fuse rapidly, the bead assumes a violet colour, shewing the presence of manganese.

The analysis of this mineral was conducted in the following manner:—

1. 20 grains, when ignited in a platinum crucible, lost 0·31 grains of its weight. This loss was considered as moisture.

2. I found it partially, but not completely, decomposed by muriatic acid; 20 grains of it were treated with muriatic acid till every thing soluble was taken up. The portion unacted on had still a red colour. It was fused with twice its weight of anhydrous carbonate of soda; most of the iron and a portion of the cerium were dissolved by the muriatic acid. But the silica and lime remained undissolved. As from a previous analysis I had ascertained the nature of the constituents, the two solutions were mixed together, and the ingredients were separated in the following way:—

3. The whole being evaporated to dryness, and the dry matter digested in water, acidulated with muriatic acid, the liquid was thrown on a weighed filter to collect the silica. After washing, drying, and igniting the silica, its weight was found to amount to 9·22 grains.

4. The liquid thus freed from silica was rendered as

neutral as possible, and then digested with benzoic acid for about half an hour. The whole was then passed through a weighed filter. The liquid that passed through the filter was colourless; the iron in the state of benzoate was retained on the filter. Benzoic acid was used instead of benzoate of ammonia, because I knew from previous experiments that benzoate of ammonia throws down cerium as well as iron, which is not the case with benzoic acid. The benzoate of iron left on the filter was washed with a solution of sal-ammoniac till every thing soluble was taken up. Had I washed it with water, as it contained an excess of acid, the greater part of the benzoate of iron would have re-dissolved. The benzoate of iron being dried and ignited left 1·09 grains peroxide of iron.

5. The colourless liquid thus freed from iron, was precipitated by ammonia, and the precipitate collected upon a weighed filter. It was a white transparent jelly, which took a very long time to wash it properly; but it gradually acquired colour by exposure to the air; and after being dried and ignited in an open vessel it was red. It was peroxide of cerium, and weighed 5·19 grains = 4·813 grains of protoxide of cerium.

6. The liquid thus freed from cerium was precipitated hot by oxalate of ammonia, and the precipitate was collected on a weighed filter, washed, dried, and ignited; it amounted to 4·48 grains, and was carbonate of lime = 2·5 grains lime.

7. Nothing else could be found in the liquid when treated with carbonate of ammonia.

The constituents thus found are

Moisture - - - - - - - -	0·31	or	1·55
Silica - - - - - - - - -	9·22	,,	46·10
Peroxide of iron - - - -	1·09	,,	5·45
Protoxide of cerium - - -	5·19	,,	25·95
Lime - - - - - - - - - -	2·50	,,	12·50
	18·31		91·55

The loss of 8·45 per cent. rendered it probable that the mineral contained an alkali. To determine this point, 28 grains of it in fine powder, were intimately mixed with 50 grains of litharge and 25 grains of nitrate of lead, and fused for ten minutes in a covered platinum crucible. The glass was dissolved in nitric acid, and the silica separated in the usual way. The lead was then thrown down by sulphuric acid, and the last portions of it by sulphuretted hydrogen gas. The oxides of cerium, of iron, and the lime, were then thrown down by carbonate of ammonia. The residual liquid was evaporated to dryness, and the ammoniacal salts driven off by heat, a salt remained, which after solution, evaporation, and ignition, was found to weigh 6·87 grains, but it was impure. After some attempts to purify it I mixed it with chloride of platinum, (after converting it into chloride,) and alcohol, and evaporated to dryness. The dry yellow residue was digested in common spirits, and after every thing soluble was taken up, I dried the potash chloride of platinum, and exposed it to a very strong red heat. By this means the platinum was reduced to the metallic state. It was weighed, and from the amount of weight, that of the potash chloride of platinum was determined. The quantity of potash indicated was almost exactly 2 grains, which amounts to 8 per cent. Hence, the constituents of thulite are

			atoms.
Silica - - - - - - - - -	46·10	,,	23·05
Peroxide of cerium - -	25·95	,,	3·7
Lime - - - - - - - - -	12·50	,,	3·57
Potash - - - - - - -	8·00	,,	1·33
Peroxide of iron - - - -	5·45	,,	1·1
Moisture - - - - - - -	1·55	,,	1·38
	99·55		

The atoms of silica amount to 23·05, while those of all the bases are 9·7. So that if we consider the mineral as composed of bisilicates, there is an excess of 3·65 atoms. This excess however is easily accounted for. The thulite analyzed was interspersed with numerous grains of silica, varying in size from that of a pea to an almost microscopic globule. Though I was at the utmost pains to exclude these grains from the portion subjected to analysis, and carefully picked out all the pieces of thulite, which appeared free from silica when viewed through a microscope, yet, in consequence of the extreme minuteness of the silica, it was impossible to exclude the whole. Hence the reason of the excess of silica, which I believe to be only apparent. The constitution of thulite may be stated as follows:—

3 atoms bisilicate of cerium.
3 atoms bisilicate of lime.
1¼ atom bisilicate of potash.
1 atom bisilicate of iron.

Whether the water be an essential constituent or not is not easily determined. Probably it is only mechanically lodged in the pores of the mineral. The constituents of thulite may be represented by the following formula:—

$$3 \text{ Cer. } S^2 + 3 \text{ C } S^2 + 1\tfrac{1}{4} \text{ K } S^2 + f S^2$$

Whether all these bisilicates be essential to the mineral can only be determined by the analysis of purer specimens than I possessed. Were the bisilicate of cerium the only essential ingredient, *thulite* would differ from *cerite* by containing twice as much silica. Cerite is a simple silicate of cerium, while the cerium in thulite is in the state of bisilicate.

Mr. Richardson analyzed in my laboratory *cyprine* which accompanies thulite. Its specific gravity is 3·2278, and its constituents,

			atoms.
Silica	38·80	,,	19·4
Alumina	20·40	,,	9·07
Lime	32·00	,,	9·14
Protoxide of iron	8·35	,,	1·8
	99·55		

It is obviously a garnet, and analogous to grossularite in its composition. No trace of copper could be detected in cyprine.

ARTICLE III.

Analysis of Arden Limestone. By THOMAS THOMSON, M. D. F. R. S., L. and E., &c. Regius Professor of Chemistry in the University of Glasgow.

ARDEN limestone is found about six miles south-west from Glasgow, and is well known and highly valued, because it furnishes a lime which sets readily under water.

It is a compact opaque limestone, with a grey colour and splintery fracture. Its streak is white, and its specific gravity 2·698.

1. 50·33 grains of this limestone were dissolved in nitric acid. The loss was 21·5 grains, which was chiefly carbonic acid.

2. The undissolved matter weighed 7·89 grains. It was fused with carbonate of soda, and analyzed in the usual way, and was found to consist of

Silica - - -	6·33
Alumina - -	1·56
	7·89

3. The nitric acid solution was evaporated to dryness, the residue was re-dissolved in water, and thrown down by caustic ammonia. A red matter fell, weighing, after washing and ignition, 3 grains, and was peroxide of iron.

4. The lime was precipitated by carbonate of ammonia. The carbonate being collected, washed and dried, and heated to incipient redness, weighed 39·4 grains.

Hence, the constituents are

Carbonate of lime - - -	39·4	,,	78·28
Peroxide of iron - - - -	3·0	,,	5·96
Silica - - - - - - - -	6·33	,,	12·57
Alumina - - - - - - -	1·56	,,	3·09
	52·29	,,	99·90

When Arden lime, in the state of quicklime is dissolved in muriatic acid, and the solution concentrated, it gelatinizes; a sufficient proof that the silica, during the burning of the limestone, had combined with lime. To this silicate of lime probably is owing the property which the lime has of setting under water.

Article V.

Notice of some Recent Improvements in Science.

By the Editor.

One of the most important objects in establishing the present Journal being to afford information in reference to the progress of science abroad, I intend in the following article, which will be repeated from time to time according to the supply of materials, to throw together in a connected form an account of some important improvements which have recently been made in several branches of physical science. The labour necessary in preparing such articles as those individuals must be aware who have engaged in similar avocations, is so considerable, that I trust to the reader's indulgence in respect to any errors or omissions into which I may have inadvertently fallen.

I. ACOUSTICS.

It has been recently observed by M. Breschet, that in many of the chondropterygious fishes, as the skate, torpedo, &c., there are open ducts, leading out externally, by which a communication is established between the centre and the membranous cavities of the labyrinth, while in many of the osseous fishes, especially the *cyprini* or minnow tribe, and the *clupeae* or herring tribe, &c., an opening exists between the swimming bladder and the labyrinth. He has likewise detected in the sacs of the labyrinth in man and vertebrated animals, concretions which he terms *otolites* and *otoconies*. *(Ann. de Chim.*, lvi.*)*. M. Cagniard Letour has obtained some curious results from his experiments on the sonorous vibration of liquids, and has attempted to explain the use of the concretions observed by Breschet. In employing a glass tube one metre in length, closed at the bottom, and filled with water, he found that when rubbed with a moist cloth, a sound was produced resulting principally from the longitudinal vibration of the column of water, yielding 790 vibrations in a second. A syphon, open at both ends and filled with water, under the same circumstances, afforded an acute sound. Hence, we can account for fishes hearing in cases where their auditory organs contained no gaseous matter. He tried the effect of vibrations upon other liquids. Several substances more dense than water afforded more acute, others, more grave sounds than that liquid.

Among the first are carbonate of potash at 71°, and muriate of lime at 87°. Among the second, sulphuric acid at 150°; sulphuret of carbon and mercury. The same observation holds with liquids possessing an inferior density to water. He concludes, 1. That the liquids in human ears are contained partly in species of tubes. 2. That these tubes or canals are osseous. 3. That the semicircular canals have a curviture answering to that of the syphon. The ound appears to be increased by introducing a solid in contact with the water; for, with a water hammer containing several small rounded stones, the globular vibration of the liquid took place without requiring to have any impulse communicated to it, as with the common hydraulic hammer. Hence, he conceives that the concretions in the labyrinth may facilitate the globular vibrations of the liquid in which these bodies are suspended. Latour and Breschet are both engaged in the further prosecution of this interesting subject. The latter is investigating the functions of the semicircular canals in the slug.

II. ELECTRICITY.

M. Peltier * has obtained some important results from his experiments on electric currents. He finds, 1. That every electric current, whatever be its intensity, elevates the temperature of homogeneous conductors. 2. That the temperature is equal over the whole length of the wire, with the exception of the extremities, where it increases or diminishes according as the bodies to which the conducting wires are attached are good or bad conductors. Thus, a zinc wire between copper and iron wires of the same diameter affords with the same current different temperatures at each of the extremities.

3. Whatever be the length of a conductor the elevation of temperature is the same under the same current, even when the extremity of the conductor is plunged into a cold liquid. In order to obtain the same quantity with a more imperfect conductor, it is necessary to increase the energy of the electrical source. If a complete current of 20° is procured, the elevation of temperature will be 10° over the whole length of the wire. Hence, it is the quantity of electricity completing the circuit which determines the elevation of temperature, and not the quantity detained. With a current of 15°, and a wire of 0·8 diameter, the temperature of the latter was 2°·4; with a current of 30° it was 7°, that is in the proportion of 2 to 3, or with a double

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* Ann. de Chim. lvi. 371.

current or half section of the conducting wire the temperature is trebled.

4. When wires of different conducting powers were alternated and employed to convey the electric current, he found that when the negative current passed from a good into a worse conductor, the greatest elevation of temperature occurred, as from copper to iron, lead, or tin. The contrary took place with the positive current. When the negative current passed from the zinc to the iron, the temperature was 30°, but in the case of the positive current the elevation was only 13°.

It is remarkable that the temperature is higher when there is a solution of continuity. Thus, when two copper wires were brought in contact with two plates of bismuth, an elevation of temperature was exhibited, but disappeared on soldering the metals.

Professor Marianini,* who is actively engaged in philanthrophic endeavours to render electricity beneficial to the cure of the diseases of his fellow creatures, has inferred, from numerous experiments upon frogs, that when their organs of motion are subjected to the influence of an electric current, the electricity accumulates, until by its tendency to flow back, it opposes the current which contributes the new supply, so as to render the action of no effect, or to excite much more feeble contractions than at the commencement of the experiment, and that the accumulated electricity gives rise to a movement in the opposite direction to that proceeding from the electrometer, when the circle is interrupted, and hence, a contraction is induced. A frog was electrified for five hours, the circle was interrupted, and contractions were excited dictinctly under the action of the returning current.

Upon these principles Marianini was induced to try the effect of galvanism upon a patient affected with palsy, after the failure of other remedies, and having succeeded in producing a cure, he applied it in several cases with equal benefit. (*Ann. de Chim.* liv. 366.)

Into one of these cases I consider it proper to enter particularly. The Countess M. Fenerazoli Sandi, aged 23 years, on the 5th of May 1827, in crossing the room fell on the floor, and in endeavouring to rise, perceived that she had lost the use of her legs, and that all sensation had disappeared in that part of her body. Marianini was called in on the 25th of June, after several able physicians had failed in doing her any good. He began the treatment with a voltaic pile, composed of 58 plates of copper, and as many of zinc.

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* Ann. de Chim. lvi. 387.

Each pair was separated from the succeeding by a piece of cloth immersed in salt water. A slip of lead leading from the positive pole surrounded the upper part of the limb, and a similar slip, leading from the negative pole, was connected with a plate of tin placed between the instep and the toes when a shock was to be given. 150 shocks were first given to one of the limbs, and then an equal number to the other, then to both simultaneously 300 shocks. Between each shock an interval of two seconds was observed, and a rest for three minutes after 40 or 50 shocks. Sometimes the electric fluid was communicated for the sake of variety, in a current, in a circuit, or by a needle point, which communicated a pricking pain to the patient. This treatment was continued for an hour, and was repeated on the 26th, 27th, and 28th of June. On the 29th the number of plates was increased to 75. The sensation experienced was so disagreeable that a wet towel was wrapped round the limb. This lasted till the end of July. He substituted an apparatus with a circuit of 100 vessels. *(couronnes de cent tasses.)* The net superficies of the plates was three square centimetres, and the liquid conductor was sea water.

The number of shocks during the day was 800. Until the 6th of July the Countess felt no signs of improvement, that is 12 days after having commenced the treatment. On the 9th, she could perceive, by touching it, that her foot was in contact with a moist body. On the 13th, the electrification by puncture caused great pain, although only made with five pair of plates. On the 15th, the patient could put her foot to the ground, but with fatigue. On the 22d she was electrified for the last time, and walked without being fatigued.

Marianini reports the cases of six other persons of various ages whom he had treated in a similar manner successfully. Some of these had previously been bled with leeches, and their spines stimulated by sinapisms. It must be added, however, that Marianini was not successful in any other cases, although we are not informed how many patients were subjected to the same method of cure. Let it be borne in mind, however, that if by the application of the electric influence, even five out of a thousand of our fellow creatures can be restored to health, from helplessness and misery, the physician is not justified in withholding the assistance of such a powerful agent.

M. Matteuci[*] in examining the pneumogastric nerves, could observe no current in them. He concludes that some foreign agency was interposed when any developement was exhibited, and that although, in all probability, the secretions depend upon the presence of opposite electrical states in the hearing organs, no means have yet been devised for appreciating their existence.

III. MAGNETISM.

Declination of the Magnetic Needle.—The mean oscillation or difference between the easterly position of the magnet in the morning, and its western direction in the afternoon, at Frieberg, is exhibited in the following table, according to H. W. Dove. (*Poggen. Ann.* xxxi.)

March . .	11′	12″·8
May . . .	12	41·6
June . . .	12	58·8
August . .	12	21·2
September .	11	25·8
November .	8	37·8
December .	3	49·8

The mean oscillation for March, June, September, and December, is 9′ 51″·8. The regular increase from the cold to the warm months is very distinct.

The removal of the extreme of the magnetic meridian and its position, is as follows:

	A. M.		EASTERLY.		A. M.		WESTERLY.	
March . . .	8^h	20′	4′	44″·6	1^h	20′	6′	28·2
May	8	20	4	30·7	1	20	8	10·9
June	7	20	5	33·3	1	40	7	26·5
August . .	7		4	43·4	1	20	7	37·8
September .	7	20	2	48·8	1		8	37
November .	8	20	1	36·6	1	40	7	1·2
December .	7			8·7	1		3	41·1

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[*] Ann. de Chim. lvi. 439.

The westerly deviation is therefore greater than the easterly.

In the following table the time is exhibited during which the needle remains to the west and east of the magnetic meridian:—

	WESTERLY.			EASTERLY.	
March . .	10^h	20′	-	13^h	40′
May . . .	10	—	-	14	—
June . . .	10	—	-	14	—
August . .	8	—	-	16	—
September .	8	20	-	15	40
November .	8	—	-	16	—
December .	13	—	-	11	—

The inclination of the needle near Freiberg is stated by Humboldt to be at 250 metres (273·41 yds.) under the surface, 67° 35′·5, and on the surface, 67° 32′·99.

Reich (*Pogg.* xxxi.) gives the result of three years, not the mean however, of the monthly summary, but of the whole year:—

1831. 67° 24′·80. | 1832. 67° 22′·65. | 1833. 67° 20′·15.

Lohrmann ascertained the inclination for Dresden to be 67° 26′·34. The observations in these instances were made with Gambey's modification of the magnet for measuring the inclination.

The declination of the needle at Sitka, on the NW coast of America, according to Erman, is 28° 19′ E, the inclination 75° 43′.

IV. PNEUMATICS.

Mean Height of the Barometer at the Sea.—This is a subject which has latterly attracted much attention. Professor Schouw of Copenhagen, more especially (*Poggendorff's Ann.*) has collected numerous good observations, and has drawn some remarkable inferences, which are strikingly corroborated by the following tables, extracted from my own observations with an excellent instrument made by Cary. They illustrate an interesting law by which the barometer is depressed as we approach the equator.

The numbers are corrected for temperature by the attached thermometer. The observations were made at 10. *a. m.*

N. Atlantic.—N.E. trade.

N. L.		BAR.
35° 36′	-	30·329
34 4	-	30·389
31 1	-	30·212
27 24	-	30·024
24 45	-	29·974
20 52	-	29·910
17 29	-	29·868
6 21	-	29·882

S. Atlantic.—S.E. trade.

S. L.		BAR.
5° 32′	-	29·853
8	-	29·821
13 7	-	29·946

S. Atlantic.—S.E. trade

S. L.		BAR.
22 19	-	30·063
28	-	30·094
29 40	-	30·152
32 16	-	30·121
33 30	-	30·158

S. Indian Ocean.—S.E. trade.

S. L.		BAR.
31° 55′	-	30·233
27 48	-	30·123
19 28	-	29·934
13 26	-	29·856
9 43	-	29·843

From these tables it is obvious that the height of the barometric column is increased as we recede from the equator, at which part of the earth's surface it appears to assume a stationary elevation, which may be taken as a close approximation to the mean density at the level of the sea. The standard barometric pressure for Britain has usually been considered to be 29·820, while the mean of the lowest heights in the observations previously stated is equivalent to 29·844.

The mean of eight observations at the Cape of Good Hope gives for the height of the barometer 29·861 inches.

With regard to the Atlantic Ocean, Schouw sums up his deductions under five heads:—

1. There is a zone between 0° and 15° possessing an elevated temperature where the rains are periodic, the annual mean of the barometer lying between 337‴ and 338‴.

2. A zone between 15° and 30°, where steady winds preserve the air dry, where rains seldom fall, the barometer being 338 to 339.

3. In the third zone, between 30° and 45°, the dry winds are interrupted, especially in winter, by the S.E. wind, or returning trade breeze, which takes up the moist and hot air of the torrid zone, and produces aqueous precipitations. The mean barometric pressure is between 339‴ and 337‴.

4. The fourth zone is comprised between 45° and the polar circle. It receives during the whole year, and especially in summer, the returning trade wind, which, in consequence of its meeting with colder winds, occasions frequent rains. The barometer is 337‴ to 333·5‴.

5. Beyond the polar circle, in the fifth zone, the mean barometric pressure increases.

Mean Temperature of the Air.—The mean temperature of different places on the earth's surface, is a point of much importance, in reference particularly to its steadiness, during a given period. Because by such data, we are enabled to determine whether the globe possesses a calorific focus from which heat is continually emanating, or whether, according to some philosophers, it is gradually throwing off the heat, which its whole mass was originally possessed of.

Laplace has shewn in his observations on the ancient eclipses, that the temperature of the earth has not varied for 2500 years, the $\frac{1}{100}$ of a degree.

Fourier as has already been mentioned (*Records of General Science.* vol. i. p. 70,) proved that the cooling cannot have exceeded the $\frac{1}{37600}$ of a degree during a century. And M. Arago demonstrated that during 2001 years, the maxima of cold have not increased.

Libri (*Ann. de Chim.* lii. 395,) has drawn the following conclusions from his analysis of different theories. 1. In the interior of the earth, the temperature of the strata, increases or diminishes with the depth. 2. From direct observations, the calculation of eclipses, and the mathematical theory of heat, it appears to be demonstrated, that the mean temperature of the globe has not varied during the historic period. 3. Future observations may perhaps enable us to ascertain if the moon has attained a state of calorific equilibrium, or if its mean temperature varies. 4. In a given time the cooling of each stratum in the earth being proportional to the quantity of heat, the cooling will be more rapid in the hottest strata towards the centre of the earth. Hence, in order to study the future variations of the mean temperature of the earth, it will be necessary to make experiments with thermometers, deposited at very considerable depths in the earth.

It is obvious, however, that we are extremely limited in our means of determining temperatures at great depths, the most distant point from the surface which has yet been attained in this country (250 fathoms,) being a most insignificant fraction of the earth's radius.

There are several methods of ascertaining the mean temperature of terrestrial localities, which have been employed with considerable success. Registers of the thermometer have been kept during the several days of the year, and a mean struck of the whole observations. The altitude of a mercurial column has been noted, and the density of the air has thus been applied to discover the temperature, by means of calculations which are sufficiently well known. The temperature of deep springs has been considered as an index of the mean temperature of the locality in which such aqueous sources occur.

These methods, however, do not apply equally well to small as to great elevations above the level of the ocean.

The depth at which an invariable temperature is met with, varies in different situations. M. Arago found that at 25 feet, (26·6 English feet,) below the surface of the earth, the thermometer was not steady, and did not indicate a constant mean temperature. This may be ascribed to the influence of the variable atmospheric temperature. Taking advantage of this inference, Boussingault conceives that in climates where the temperature is tolerable equable, the earth can be affected to but a very slight extent by slight alternations of heat, as happens in equinoctial situations, (*Ann. de Chim.* liii. 225.) In 1830, during his residence at Vega de Zupia, he instituted a set of experiments with the view of settling this point, and came to the conclusion, that in less than an hour, a traveller may ascertain the mean temperature of any place between the tropics, whatever its elevation above the level of the sea may be. To prevent the effect of atmospheric influence, he experimented under cover of a cottage or in the shade. The thermometer was introduced into a hole, which was deep enough to allow the bulb to be a foot below the surface, the hole was then closed up by a bit of paper or other convenient substance. The temperature of Zupia was thus found to be between 21°3 (70°3 F) and 21°5 (70°7 F,) which it must be admitted is a close approximation, considering that the observations amounted in number to twenty. At Marmato the thermometer placed 1 foot below the surface, 1426 metres above the sea, ranged between 70°·3 and 70°7. In the Valle de Cauca, 1050 metres above the sea, the range of seven observations was 23°6 (74°4) and 23°8 (74°8.)

At Puracé, 2651 metres of elevation, the thermometer placed in similar circumstances stood at 13°1 steadily, during six observations on two separate days. At Quito, with an elevation of 2914 metres, the mean temperature according to the determination of Colonel Hall and M. Salaza, during the whole year is 15°·5 (59°9 F,) which corresponds exactly with the results of Selaza, obtained by placing the thermometer 1 foot under the surface. Boussingault from these, and a few additional instances concludes, that at least, between the 11° N. L., and 5° S. L., this method of ascertaining the mean temperature holds good.

The mean temperature of the shores in the neighbourhood of the equator, has been a subject of discussion. Humboldt fixed upon 27°5 (81°5 F.) Kirwan 29° (84°2.) Brewster 28°2 (82°7.) Atkinson 29°2 (84°5,) as the temperature of the equator. Hall and Boussingault again, have found the temperature of the torrid zone to vary between 26° (78°8 F) and 28°·5 (83°3 F.) I consider these facts too important to be overlooked, and am happy in being able to communicate to travellers such a simple, and at the same time, so apparently correct a method of ascertaining the mean temperature of intertropical places. In connexion with this subject we may consider the

Temperature of Springs. (Pogg. Ann. xxxi. 365.)—Arago remarked that the increase of the temperature of the earth might be estimated by the depth of springs. Spasky considers that the value of this increase may be determined with accuracy. From his observations on the springs of Vienna he has drawn this equation,

$$\mathrm{T} = \mathrm{A} + a\,x$$

in which T is the observed temperature, A the (unknown) temperature on the surface, a the depth, and x the increase of temperature for 1 foot in depth. As the value of each observation depends on the quantity of water delivered by each well in 24 hours, each equation must be multiplied with this quantity of water. The general expression therefore is

$$m\,\mathrm{T} = m\,\mathrm{A} + m\,a\,x$$

where m represents the quantity of water in 24 hours.

For Vienna Spasky gives

$$\mathrm{A} = 8{\cdot}0311.$$

$$x = 0{\cdot}0117716.$$

Mean error of A 0·08601.

Mean error of x 0·00065.

Mean temperature of the atmosphere 8° 2 R. The value of x being found, we obtain 85 feet, or less than 27 metres for increase in the depth for each degree of Reaumur.

V. CHEMISTRY.

Table of the specific heat of bodies.

Avogadro has recently made experiments upon this interesting subject. The following table contains the results of these trials, with the numbers affixed by other experimenters.*

	Avogadro.		
Carbon	0·257	0·25	Crawford
Protoxide of lead	0·050	0·049	Gadolin
Red oxide of mercury	0·050	0·501	Lavoisier and Laplace
Protoxide of tin	0·094	0·096	Crawford
Deutoxide of copper	0·146	0·227	Crawford
Oxide of zinc	0·141	0·137	Do.
Anhydrous lime	0·179	0·223 0·217	Crawford Lav. and Laplace
Peroxide of iron	0·213	0·167	Gadolin
Red oxide of lead	0·072	0·068 0·059 0·062	Crawford and Kirwan Gadolin Lavoisier and Laplace
White oxide of arsenic	0·141		
Alumina, anhydrous	0·200	0·185	Gadolin
Deutoxide of tin	0·111	0·096	Crawford
Peroxide of manganese	0·191		
Quartz	0·179	0·195	Crawford (agate)
Sulphuret of iron	0·135		
Sulphuret of lead	0·046		
Cinnabar	0·048		
Yellow sulphuret of arsenic	0·105		
Chloride of sodium	0·221	0·226	
Chloride of potassium	0·184		
Chloride of lime	0·194		
Deutochloride of mercury	0·069		
Protochloride	0·041		
Red oxide of iron (hydrous)	0·188		
Alumina (hydrous)	0·420		
Lime (hydrous)	0·300		
Potash (hydrous)	0·358		
Carbonate of lime	0·203	0·256 0·207	Crawford Gadolin
Carbonate of potash (anhydrous)	0·237		
Carbonate of soda (anhydrous)	0·306		
Sulphate of lime (anhydrous)	0·190		
Sulphate of potash	0·169		
Sulphate of soda (anhydrous)	0·263		
Sulphated protoxide of iron (anhydrous)	0·145		
Sulphate of copper (anhydrous)	0·180		
Sulphate of zinc (anhydrous)	0·213		
Nitrate of potash	0·269		
Nitrate of soda	0·240		
Sulphate of lime (hydrous)	0·302		

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* Ann. de Chim. lv. 92.

Atmospheric Air.—According to Berthollet, by the usual phosphorus eudiometer, the remaining azote is increased by the phosphorus vapour $\frac{1}{40}$ of its volume. To satisfy himself upon this point, Brunner passed a quantity of atmospherical air from a gas holder, first through mercury and chloride of lime, and then through red hot iron filings. The gas thus freed from oxygen was placed over mercury, the temperature and pressure being noted. A stick of dry phosphorus was next allowed to remain for some time in the gas, but produced no change in its volume. Sometimes, after standing many days, a slight dimunition took place, but never amounting to 1 per cent., which was ascribed to the admission of a small portion of oxygen.

Tralles, from theoretical views, calculated that the quantity of oxygen in atmospherical air diminishes with the height, and that at the surface of the sea, air contains

	21·00	per cent.
1000 feet above the sea	20·90	"
8000 Do. - -	20·22	"

Saussure found the quantity less upon the hills than in the vallies, (1·25 less) by means of Priestley's eudiometer. Berger, with sulphuret of potassium, phosphorus, and nitrous oxide, estimated the proportion at between 20 and 21 per cent.

Configliachi observed that with phosphorus the proportion of oxygen was smaller below 50° than above 64½°.

The mean of 14 experiments by Brunner gives for the proportion of oxygen in common air, determined by means of phosphorus, 20·915 per cent.

The smallest quantity obtained was 20·75, the temperature of the residual azote being 50° F, and the pressure 555·9 millimetres, and the greatest result was 21·11 when the thermometer was 53½° F, and the barometer at 556.0 mill. Both experiments were made about 7 *a. m.* (*Pogg.* xxxi. 1.)

Compounds of Carbon and Hydrogen.—Dumas and Boullay have endeavoured to prove, by numerous analyses, that, 1. A compound of carbon and hydrogen acts as a base, analogous to ammonia; 2. That alcohol and ether are hydrates of this body; 3. That carbohydrogen forms with hydracids, anhydrous compound ethers; and 4. That the same body with oxygenacids forms compound ethers containing an atom of water.

Dumas conceives that alcohol contains hydrogen united to water, and hydrogen united to carbon. Following out these theoretical considerations, he has examined the product of the distillation of alcohol with chloride of lime in solution which he terms *chloroforme*. It consits of

Carbon - - - -	10·24
Hydrogen - - -	0·83
Chlorine - - -	88·93
	100·00

The formula for this compound is obviously $2 C + H + 3 Ch$.

Bromoforme is prepared by treating bromide of lime with alcohol, or pyro-acetic-spirit. It consists of

Carbon - - - -	5·44
Hydrogen - - -	0·47
Bromine - - -	94·09
	100·00

and its formula is $3 C + H + 3 B$.

Iodoforme is formed in a similar manner, and contains

Carbon - - - -	3·20
Hydrogen - - -	0·33
Iodine - - - -	96·47
	100·00

corresponding nearly with $2 C + H + 3 I$.

Chloral has its composition expressed according to Dumas, by the formula, $4 C + H + O + 3 Ch$.

Mercaptan. (*Ann. de Chim.* lvi. 113.)—When sulphovinate of barytes is distilled with a solution of sulphuret of barium, an ether passes over which swims on water, and may be freed from sulphuretted hydrogen attached to it by agitation in water, and separated from water by chloride of lime. Thus purified, it is colourless, smells like assafœtida, and burns readily. By distillation it is separated into a more volatile portion, termed by Zeise, *mercaptan*, an extraordinary appellation, from its affinity for mercury, (*corpus mercurium captans*,) and into a more fixed substance called *thealic ether*.

Mercaptan, when obtained pure from the mercaptide of mercury, is colourless, with a smell of assafœtida. Sp. gr.

0·842. Boiling point 62° (143° F.) Very soluble in alcohol and ether; acts with violence on deutoxide of mercury, forming a compound of $Hg + 2\,Su + 4\,Su + 4\,C + 10\,H$. So that the composition of mercaptan is $4\,C + 10\,H + 2Su$. The *mercaptide of mercury* melts at 86° C, resembles fused chlorale of potash, it is decomposed at 175° C; it is insoluble in water. *Mercaptide of gold* consists of $2\,Au + 4\,C + 10\,H + 2\,Su$, is an amorphous mass without colour, and is not decomposed at 220°. Mercaptide of platinum resembles that of mercury in composition. Mercaptides of potassium and sodium are alkaline.

Zeise conceives the state of the combination of the elements of mercaptan may be represented by $(4\,C + 10\,H + S) + (2\,H + S.)$ Liebig makes it $4\,C + 12\,H + 2\,S$.

Absorption of deutoxide of Azote by salts of Protoxide of Iron.—Priestley first observed that the salts of protoxide of iron absorb deutoxide of azote; and Davy afterwards ascertained that a cubic inch of a saturated solution of sulphated protoxide of iron, absorbs 12 cubic inches of this gas. All the soluble salts of protoxide of iron, without exception, possess the property of absorbing a determinate proportion of deutoxide of azote, which is proportional to the base. To determine directly the quantity of gas absorbed, Liebig's apparatus was employed by Pelligot, (*Poggendorff's Ann.* xxxi. 24.) The apparatus was weighed, a determinate portion of salt introduced, the weight noted, a little water poured in, and the weight a third time observed, then it was attached to a Woulf's bottle by means of a ribband of caoutchouc, from which the dry gas was disengaged. By means of this apparatus, with the necessary precautions, he obtained the following results:—

15·433 gr. (1 gramme) of anhydrous sulphated protoxide of iron, absorb 4·07 cubic inches (66·7 cub. cent.) or 9· per cent. of its weight. 15·433 gr. chloride of iron absorb 4·339 cubic inches (71·1 cub. cents) or 10·7 of its weight per cent.

The solutions which absorb deutoxide of azote are not altered, for the salts remain in the state of a protoxide, and can be restored to their former state by heat. Sometimes a little peroxide of iron is formed, and a little azote is disengaged, but these partial decompositions proceed from the independent oxidation of the protoxide, and are not connected with the gas absorbed; and this is further proved by the fact, that if the solution is evaporated in a vacuum, the gas disappears, and the salt remains unaltered. It may be observed, however, that ferro-prussiate of potash, does not produce a Prussian blue colour, with the salt in this state, but forms a reddish brown flocky precipitate, which changes its colour to blue on exposure to the air.

Phosphate of soda, as well as all salts which by double decomposition produce insoluble precipitates, with the salts of protoxide of iron, form when the last salts are saturated with deutoxide of azote, compounds in which the gas remains in combination. The precipitate occasioned by phosphate of soda is reddish brown, and passes in the air into phosphate of iron. But these combinations are so extremely unstable, that it becomes almost impossible to study their nature.

With regard to the other metallic solutions the effect is quite different. The gas is absorbed by chloride of tin and nitrate of mercury, but the chloride decomposes the deutoxide of azote, and takes up the oxygen necessary to produce an oxide of tin. A solution of nitrate of mercury saturated with the gas, deposits speedily a crystallized salt which is a hyponitrate and less soluble than the nitrate.

The circumstances to which we have directed our attention above, deserve to be prosecuted, as they have no analogy in mineral chemistry.

Reduction of Chloride of Silver, (*Journal de Chimie d'Erdmann*, 1833, p. 270.)—The best method of reducing chloride of silver is that of Mohr, which consists in mixing the chloride with the third of its weight of colphane, and heating the mixture moderately in a crucible until the flame ceases to be of a greenish blue colour, then to increase the heat, for the purpose of fusing the silver and collecting it at the bottom of the vessel.

BASES.

Method of procuring Selenium.—Brunner employed, for the purpose of extracting selenium, the refuse from the sulphuric acid manufactory at Luckawitz, in Bohemia, (*Poggendorff*, *Ann.* xxxi.) The dried refuse is to be distilled in a glass retort; a small quantity of acid liquor first passes over, then sulphur follows, which condenses in the receiver; 100 parts of the dried matter contains 42 of sulphur. It should then be pulverised and boiled with a concentrated solution of potash till the solution is saturated with sulphur. Dilute the liquid with from four to six times its volume of water, and expose it to the air. In eight or ten days an efflorescence takes place on the surface of the liquid, which, as it separates into considerable pieces, sinks by shaking to the bottom of the vessel. When this precipitation ceases the substance is to be well washed. It consists of pure selenium. From the solution a light black matter separates, which is carbon, and may be separated from the selenium by filtration. If the solution is allowed to remain for some days in the air, after the separation from the selenium, a red powder collects on the surface, which is a combination of sulphur, with a little selenium.

To free the selenium first obtained from a small quantity of sulphur, it may be again treated with potash, but in this case, a small quantity of selenious acid remains in solution; or it may be oxidized by nitric acid, and precipitated with sulphate of ammonia.

In the same way the selenium may be separated from the compound of sulphur and selenium, which appears to be a combination of sulphuret of selenium with sulphur. If the solution be exposed to the air after the separation of the selenium and red compound, for six or eight weeks, more sulphur is deposited, with a little selenium, which may be separated by potash.

A small portion of selenium still remains in the liquid, which may be extracted by saturating the potash with muriatic acid, and then treating the sulphur which separates with potash as before. But it will be found that the quantity obtained in this way is not worth the trouble of the process.

The black pulverulent residue which remains after the distillation of the sulphur, contains a small quantity of selenium. It consists of silicious sand, charcoal, lead, lime, iron, alumina and sulphur. To separate the selenium 1 part of the matter is to be heated with 1 part of saltpetre and 2 or 3 of common salt, in a crucible, until the black colour is removed and a red tint appears. The mass is then washed, and boiled with muriatic acid till all the nitric acid is driven off, and the selenium is then precipitated by sulphate of ammonia. From 1 to 1½ per cent. of selenium is thus obtained from the residue.

Precipitation of Antimony by Sulphuretted Hydrogen, (*Ann. de Pogg*. xxviii. 481.) When antimony is precipitated from the solution of its chloride, in water mixed with tartaric acid, by sulphuretted hydrogen, it is in the state of a pure sulphuret, and retains no sensible quantity of chlorine. But when the gas passed through the liquid is insufficient to throw down the whole of the metal, the precipitate is, as M. L. Gmelin observed, a chloro-sulphuret. This compound becomes black by drying on the sand bath, and exhales fumes of chlorine and antimony.

Economical method of preparing the Protoxide of Copper, by M. MALAGUTE, (*Ann. de Chim*. liv. 216.) Fuse with a gentle heat 100 parts of sulphate of copper, and 59 crystallized carbonate of soda, and continue the heat until the mass solidifies. Pulverize it, and add exactly 15 parts of copper filings, then expose to a white heat, and keep it up for twenty minutes. Powder the cooled mass, and wash it. The residue is protoxide of copper, of a beautiful colour, and the first washings contain sulphate of soda, which may be extracted by evaporation. The oxide thus prepared costs only 4*s*. 2*d*. for 2 lb. 2 oz. 2 dr.

If we were content with calcining the sulphate with copper, or employed anhydrous carbonate of soda, the product would be less beautiful and less pure. The proportion of carbonate of soda given is sufficient to decompose half of the sulphate of copper, and a greater proportion, so far from being advantageous, would afford an oxide much less pure.

Separation of the Fixed Alkalies from Magnesia.—When the alkalies and magnesia are in the state of chlorides, the bases may be separated by converting them into sulphates, treating the solution with acetate of barytes, heating them after evaporation, and separating by water the soluble alkaline carbonate from the carbonates of barytes and magnesia.

Formerly, the separation was produced by a strong heat, which converted the greatest part of the chloride of magnesium into magnesia, by the water of crystallization converting the chloride into muriatic acid. This method, however, is not correct, because the whole of the chloride of magnesium is not decomposed, and, by consequence, a portion of it is obtained along with the soluble salt, and spirits act in the same way as water. But when chloride of magnesium is heated in a small platinum crucible, over a lamp with a double stream of air, and then a bit of carbonate of ammonia is placed in it, and the heating repeated several times, with the precaution of moistening the salt with a drop of water, the magnesia will be completely decomposed. If the dried residue be dissolved, and tested with nitrate of silver, a mere trace of the chlorine will only be detected.

Rose endeavoured to separate in this way chloride of lithium from chloride of magnesium, but of the original quantity of chloride of lithium, he only obtained 93 per cent. The remaining magnesia afforded an opalescence with nitrate of silver. The cause of the difference is, that part of the lithia, from the presence of carbonate of ammonia, is converted into carbonate of lithia, which, on account of its solubility, cannot be readily separated from the magnesia.

Chlorides of sodium and potassium may be heated frequently with carbonate of ammonia, without changing their weight. Chloride of calcium, on the other hand, undergoes a similar change with the chloride of lithium.

By access of the air, the chlorides of potassium and sodium are changed, and therefore, the preceding statement must be understood as referring to their behaviour in a covered crucible.

Rose has made some experiments upon the volatility of chlorides of sodium, potassium, and lithium, which are very important.

1·0255 grms. of chloride of potassium lost by a red heat in a small platinum crucible 6 lines in depth during the first quarter of an hour - - - - - - - - - 0·0845

During the second quarter - - - - 0·0890

1·016 chloride of sodium in the same vessel during the first quarter - - - - - - - - - - - - - 0·038

During the second quarter - - - - 0·039

A mixture of 0·932 grms. chloride of potassium, and 1·175 chloride of sodium, lost in the same circumstances

0·065. From which it appears that in mixture they retain the same volatility as when separate. Chloride of lithium is more volatile than either of the other chlorides.

1·134 chloride of potassium heated in a large crucible, 18 lines deep, lost in the first quarter of an hour 0·026 grm.

In the second quarter - - - - - - - - 0·0265

1.101 grms. chloride of lithium in the same circumstances lost in the first quarter - - - - - - - 0·017

In the second quarter - - - - - - - - 0·013

1·100 grms. of chloride of sodium in the first quarter - - - - - - - - - - - - - - - - - 0·007

In the second quarter - - - - - - - - 0·009

The relative volatilities, therefore, of these salts, beginning with the most fixed, is chloride of sodium 1, chloride of lithium $1\frac{7}{8}$, chloride of potassium $3\frac{1}{4}$, in a deep crucible, but in a shallow crucible the proportions are different, the volatility of the chloride of sodium being represented by 1, and that of chloride of potassium by $2\frac{1}{4}$, (*Pogg. Ann.* xxxi.)

Manufacture of Artificial Soda.—The calcined sulphate of soda is converted into sulphuret of sodium, by heating it with pulverized charcoal. The sulphuret is dissolved, and oxide of copper added to the hot liquid. The liquid is evaporated after filtration until its spec. grav. be 1·41 or 1·48. Then, on allowing it to remain from 24 to 28 hours, the undecomposed sulphate of soda crystallizes. The supernatant liquid is evaporated to dryness. By this process, for every 100 parts of sulphate of soda, 65 of caustic of soda are obtained. It may be converted into carbonate by heating with charcoal.

Metallic copper, as well as its oxides, can separate the sulphur from the sulphuret of sodium, but in general the protoxide is preferable. To procure this oxide, metallic copper is to be heated to redness, and plunged into water containing in solution 0·02 of nitrate of soda from Chili. The sulphuret of copper, which is the product of this process, mixed with $\frac{1}{6}$ of sulphur in powder is easily converted into sulphate by heat. These processes are followed at Hof., according to Prukkner, (*Annal de Schweigger*, b. vii.)

Separation of the Oxide of Cobalt from Oxide of Nickel, (*Ann de Chim.* lvi. 333.)—M. Persoz separates these oxides by dissolving them in nitrate or muriatic acids, adding as much paraphosphoric acid as will saturate the two oxides. Ammonia is poured in, which forms a precipitate re-dissolved by an excess of ammonia, and the liquid becomes violet coloured. When allowed to stand the excess of alkali flies off, and the solution becomes turbid in consequence of the deposition of ammonia paraphosphate of nickel, which at first possesses a greyish colour, but ultimately becomes green. When the precipitate completely subsides, the rose coloured supernatant liquor is drawn off, which, if it contains no more nickel, may be evaporated to the consistence of a syrup. The paraphosphoric acid may be separated from the oxides by carbonate of soda.

Separation of Oxide of Cadmium from Oxide of Bismuth.—Persoz has observed that the paraphosphate of bismuth is insoluble in ammonia, and that the paraphosphate of cadmium is very insoluble. Hence, this is a ready method of separating the two oxides. He prepares the acid by calcining pure phosphate of ammonia.

Separation of Oxide of Uranium from the Oxide of Cobalt, Nickel, and Zinc.—The subacetate of lead separates the oxide of uranium from the other three oxides, for a solution of this salt poured into a solution of uranium in nitric acid, occasions a precipitation of uraniate of lead, the other oxides present not being affected.

Manufacture of the Tam Tam and Cymbals of the Chinese, (*Ann de Chim.* liv. 329.)—According to M. Stanislaus Julien, the Chinese in the formation of the tam-tam, run the alloy into leaves, and then fashion it in the proper way; but according to Darcet this is impossible, because the alloy is as brittle as unanealed glass. The tam-tam and cymbals consist of

Tin	0·20
Copper . .	80
	100

The most probable mode of manufacture appears to be by running a piece modelled in sand in a font with the alloy. The piece taken from the mould is finished off, and tempered like steel. If it is distorted by being plunged while hot into cold water, the injury is rectified by a hammer. The tone appears to be given either by the tempering or by proper hammering. It is then polished by a lathe, and completed.

Method of obtaining Iridium and Osmium, after the separation of Platinum, by F. WÖHLER. (*Pogg. Ann.* xxxi.)—The black pulverulent residue which remains after the solution of native platinum in aqua regia, contains, besides the combination of osmium and iridium, a considerable quantity of free iridium, and some iron titanium. Wöhler recommends the following process for separating them: Mix equal portions of the residue and decrepitated common salt, and place them in a green glass tube, which is to be passed through a tube furnace similar to that in the apparatus of Liebig. To one end is fixed an apparatus for the production of chlorine, and the other communicates with a vessel filled with ammonia, preceded by a bulb for the absorption of the oxide of osmium. Under the tube, hot coals are to be placed, in order that the mixture contained in it, which should occupy three fourths of its diameter, may be exposed to a strong heat. The chlorine is then allowed to pass through the tube. By this operation sodium-chloride of iridium, and sodium-chloride of osmium are formed, both of which salts are soluble in water, while the iserine remains insoluble. A little chloride of osmium will be formed in the first portion of the tube. The greater portion of the oxide of osmium will have crystallized in the bulb situated at the extremity of the tube. The bulb is to be exposed to a heat so as to melt the oxide, and in this state it may be poured into a flask or glass tube. The tube may be placed on one side, so as to allow the oxides to sublime in the form of long crystals on the opposite side.

To the ammonia, which contains more or less oxide of osmium, and is coloured yellow by it, let some sal-ammoniac and carbonate of soda be added, and let the whole be then evaporated to dryness, and heated to redness in a glass retort. By this method the oxide will be reduced to the metallic state, which, by treating with water, will remain in the form of a black powder. It is then washed and dried. The oxide in the bulb may be reduced in the same manner after it has been dissolved in ammonia.

When the tube with its contents is placed in a cylindrical vessel full of water, all the soluble portion dissolves. A deep brownish red solution of double salt of iridium is formed. The liquid after standing should be decanted from the residue, which consists of iserine, and some pieces of osmium and iridium. The fluid drawn off is distilled to separate the oxide of osmium, which may still exist in it. When the whole of the acid has passed over, the distillation is stopped and the solution filtered. It is then to be evaporated over a fire, and during the concentration, carbonate of soda is to be added in excess, which throws down a blueish black precipitate.

The dried black mass will then be strongly heated in a Hessian crucible, and after cooling, be digested in water. The residue is a sesquioxide of iridium. The filtered salt solution contains, besides common salt and carbonate of soda, also chromate of soda, which gives it a yellow colour.

The sesquioxide of iridium contains, besides osmium, some oxide of iron. It is to be placed in a glass tube, and hydrogen passed over it at a red heat till water ceases to be formed. Metallic iridium thus obtained is a black powder. It contains much caustic soda, which was chemically combined with sesquioxide, and is now taken up by water. By digestion in muriatic acid the iron is removed. After washing, it may be placed between layers of filtering paper, and pressed for several hours with a screw press. Heated then in a crucible, it is obtained in the form of a firm polished grey mass. Metallic iridium may be obtained by a shorter method, but not in such purity; by evaporating the solution of sodium chloride of iridium to dryness, heating to redness, so as to melt the salt, and begin to volatilize the chloride of sodium. The iridium will thus be reduced, and remain, after digestion in water, as a grey or black metallic powder.

Use of Iridium in the manufacture of Porcelain. (Pogg. xxxi.)—The substances hitherto employed for painting porcelain consisted of combinations of oxide of iron and oxide of cobalt, the former producing grey and Indian ink tints, and the latter the brown or blueish hues. It has been lately ascertained, however, that iridium and rhodium communicate to porcelain grey and black tints. The black colour of iridium is very deep and pure, while its grey tint is complete, without any tendency to blue or brown. The residue from the Russian platinum mint contains iridium, and is now employed at the Royal Berlin Porcelain Manufactory for painting the superior kinds of ware.

*Separation of Lead and Bismuth.**—Stromeyer dissolves both oxides in nitric acid, and boils the solution with an excess of caustic potash. The oxide of bismuth loses its water and remains in the form of a yellow powder, while the oxide of lead dissolves in the potash. The solution is saturated with acid, and precipitated with an alkaline oxalate.

To detect Copper in Lead by the Blowpipe.†—Plattner recommends the following plan for this purpose: The lead containing the copper is reduced upon charcoal to a small melted globule. Twice its weight of boracic acid is added; and the globule being so placed as half of it to touch the acid and half the charcoal, it is melted into a glass. The lead oxidizes and dissolves in the acid. In this way the lead is so oxidized that the small residual globule will readily afford with the salt of phosphorus and tin the peculiar characters of copper.

ACIDS.

Distillation of Nitric and Muriatic Acids.—According to Wittstock, if a quantity of saltpetre be distilled with a third of its weight of dilute sulphuric acid, sufficient to form a bisulphate of potash, a sudden and rapid extrication of nitric acid takes place at the time, when the clear mixture becomes milky, by which the liquid from gently boiling, is forced into violent ebullition, and a great quantity of salts is deposited in the retort. A similar occurrence takes place when common salt is distilled with sulphuric acid in sufficient quantity, to produce bisulphate of soda. A strong ebullition being observed on the deposition of this salt. (*Poggendorff's Ann.* xxxi. 31.)

Crenic and Apocrenic Acids.—In subjecting to analysis the water of the well at Porla in Oerebro, Berzelius discovered two new acids.‡ (*Poggendorff's Ann.* xxix. 1.) When the water is exposed to the access of air, a yellow deposit or ochre precipitates. The water yields in $\frac{1}{160000}$ parts,

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* Poggendorff, xxvi. 553. Berzelius Jahresbericht, 1834, 151.

† Pharm. Centrall. iii. 859.

‡ Porla well lies in the country of Oerebro, on the boundary of the parishes of Skagerhult, Viby, and Bodarne, on the edge of a great moor, which extends to no great depth (3 ellen) covered with sphagnum palustre, and resting on a hard bottom of sand and gravel.

Chloride of potassium	0·3398
Chloride of sodium	0·7937
Soda combined with crenic acid	0·6413
Ammonia combined partly with crenic acid and partly with carbonic acid	0·8608
Bicarbonate of lime	9·0578
Bicarbonate of magnesia	1·9103
Bicarbonate of manganese	0·0307
Bicarbonate of iron	6·6109
Phosphate of alumina	0·0110
Silica	3·8960
Crenic acid	5·2535
	29·4058

From the ochry deposit the new acids are obtained. It consists of

Crenate of iron	90·54
Carbonate of lime	3·54
Phosphate of alumina with trace of magnesia and manganese	0·38
Silica	5·54
	100·00

The temperature of the water is 44°·6 F, and the gas which is continually rising from the bottom of the well, consists of 6 vols. of azote and 1 carbonic acid.

Berzelius treated this deposit in the following manner: the ochre was boiled with caustic potash, which produced a brown solution, from which some ochre was deposited after standing for some time. This precipitate was thrown on a filter, the filtered solution boiled and iron deposited, sulphuretted hydrogen being passed through the liquid, the remaining iron in solution was separated.

Crenic acid, (*κρηνη* a well) was obtained from the alkaline solution by the following process: The liquid was supersaturated with acetic acid, and acetate of copper added. If the precipitate was green, the acid was added in greater quantity. Acetate of copper was then added as long as a brown precipitate continued to fall. The crenate of copper remained in solution in the acetic acid, and when it apparently precipitated, it dissolved again, leaving apocrenate of copper.

This is slightly soluble in the filtered liquid, but when washed, it is completely dissolved. These washings were not mixed with the liquid passing through the filter. The latter was saturated with carbonate of ammonia in slight excess. and then was gently heated to 50° C (122° F) when the crenate of copper fell down. As long as the solution continues green, it is a proof that the precipitation is not completely effected, and is to be remedied by the cautious addition of carbonate of ammonia, or by heating the solution. The crenate of copper possesses a light grey-green colour, if brown, it contains apocrenic acid.

It was then washed, mixed with a little water, and a current of sulphuretted hydrogen passed through it. The sulphuret of copper thus obtained was brown, and the solution which passed through the filter was also brown. After standing 24 hours in a corked flask, it was filtered. The metallic sulphuret was so much the longer in separating from this solution, in proportion to the quantity of water added. It frequently happens, that when the solution passes through at first clear, the metallic sulphuret begins to follow during the process of washing, in consequence of the formation of bicrenate of copper. The brown solution was heated in a corked flask at a temperature of 80° C (176° F,) and thrown on a filter. The filtered crenic acid formed a pale yellow solution, which must be kept from the access of the air, for then it is converted into apocrenic acid. By evaporation, free from the contact of air, a dark yellow mass was obtained, consisting of crenic acid, crenates of lime, magnesia and manganese, which was treated with absolute alcohol. Crenic acid and a trace of crenate of magnesia were taken up, while the other bases remained as acid salts. The alcoholic solution was evaporated, free from the contact of air. The residue possessed a yellow brown colour. It was dissolved in water, and mixed with a solution of acetate of lead. The first precipitate formed was brown, which partly dissolved, leaving a brown residue of apocrenate of lead. The solution was filtered and precipitated with acetate of lead. The precipitate was well washed, dried, excluded from the air, and a current of sulphuretted hydrogen passed through it.

The filtered solution possessed a pale yellow colour, which by evaporation, free from the action of air, yielded a thick pale opaque yellow mass, which was crenic acid in the purest state.

Crenic acid is yellow, destitute of any appearance of crystallization, without smell, and in the dry state it tastes acid, but in a dilute solution, produces no effect on the tongue, although it reddens litmus paper. It dissolves in all proportions in water and absolute alcohol. The alcoholic solution evaporated in the air becomes brown. The aqueous solution when dried assumes the appearance of a syrup. When distilled, it affords an acid liquor and a brownish yellow oil. Distilled with caustic potash, ammonia is produced. While in the retort charcoal remains, which burns completely away when the acid is pure. Crenic acid consists of carbon, hydrogen, azote and oxygen, in proportions which have not yet been determined.

It dissolves in nitric acid in the cold without change; by the application of heat some nitrous gas is disengaged, and nitric acid may be distilled off. By evaporation a yellow mass is left in the water, possessing an intensely bitter taste, which unites with an alkali when the latter is added to it, forming an alkaline crenate.

When silica is separated from a crenic acid solution, the precipitate contains crenic acid which can be separated by an alkali; but the silica by heating becomes black and disengages an animal smell, and when moist is dark grey, when dry, white.

The compounds of crenic acid and the alkalies are easily soluble in water, and in concentrated solutions resemble vegetable extracts, The salts of the alkaline earths are less soluble, and those of the metallic oxides difficultly soluble, but dissolving more or less by washing.

To determine the atomic weight of crenic acid, a solution of acetate of lead was precipitated by a portion of pure crenic acid; the precipitate was white by reflected, and yellow by transmitted light. It was washed and dried, free from access of air at a temperature of 100° C (212° F.) It weighed 0·59 grm.; decomposed by sulphuric acid 0·4165 grm. of sulphate were obtained, dried at the same temperature.

After being heated in a platinum crucible, by which operation it first became brown and gave out smoke, it assumed a white appearance and weighed 0·41 grm., acquiring no change by treatment with nitric acid. This product is the apocrenic acid combined with the sulphate of lead. Now as the weight of an atom of sulphate lead is to the crenate of lead as 41 to 59, the atom of crenic acid is 1333·4. By analyzing the crenate of lime Berzelius obtained for the atomic weight of the acid 1358·38.*

Apocrenic Acid.—Apocrenate of copper is precipitated when the ochre has been treated with potash, and acidified by acetate of copper. This is washed twice with cold water, It is then to be mixed with a little water and a stream of sulphuretted hydrogen passed through it. The solution is dark brown, and by concentration blackish brown. By absolute alcohol the pure acid is taken up and freed from the salts. A small portion remains on the filter with the sulphuret. This is taken up by acetate of potash, the solution evaporated, and the apocrenic acid dissolved in alcohol of sp. gr. 0·864. The acid may then be separated from the potash by means of muriatic acid.

To ascertain the atomic weight, apocrenates of lead and barytes were analyzed. By the former the numbers were 1693·0, and by the latter 1642·2.†

Action of Formic Acid upon some oxides and peroxides of metals.—1. Gobel finds (*Schweigg Seidel*, vii.) that solutions of gold, platinum, and palladium are not decomposed by free formic acid even at the boiling point. This acid volatilizes gradually without separating the least trace of metal; but the formate of soda completely precipitates these metals partly in brilliant spangles, and partly in the form of powder.

The solutions of nitrate of silver and mercury are decomposed by free formic acid; but the decomposition is more rapid by means of the alkaline formate.

2. The red oxide of mercury affords an easy method of determining the quantity of free formic acid, either mixed with other acids or combined with bases. The proportion

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* If we reduce these weights to convenient numbers, we have for a mean 13·458 which approaches 13·5 so nearly, that we can have no hesitation in admitting itas the atom of crenic acid.—Edit.

† 16·75 appears, therefore, the atom of apocrenic acid.—Edit.

of formic acid may be judged of by the volume of carbonic acid disengaged, when a liquid containing formic acid is heated with red oxide of mercury. The carbonic acid should be collected and estimated in a proper apparatus.

When formic acid is combined with bases, it is necessary to add, besides the red oxide of mercury, some acetic acid to set the formic acid at liberty.

3. The formates of zinc, copper, cadmium, bismuth, lead, nickel, uranium, cerium, and cobalt, when exposed to a red heat in a glass tube over a spirit lamp, are decomposed and their oxides are completely reduced. If the flame of the blowpipe is directed upon the more difficultly fusible metals, while in the tube they appear through the glass to possess the metallic lustre peculiar to them. The employment of formic acid for procuring the rare metals, is to be preferred to hydrogen, and as the price of formic acid is low, it is to be hoped that the reduction will be speedily made on a great scale.

4. Formic acid may also be used to determine the quantity of oxygen contained in the peroxides. For this purpose a determinate quantity of the peroxide is heated with formic acid. The gas disengaged, which is a mixture of carbonic acid and common air, should be collected, and the quantity of carbonic acid determined by means of caustic potash noting the barometric pressure, the temperature and moisture, and by dividing the volume of the acid by 2, the quotient expresses the volume of oxygen taken from the peroxide. Its weight is then calculated.

5. The method recommended by Döbereiner of preparing formic acid with sugar, is a very good one. The acid thus obtained always contains some acetic acid, which is detected when it is treated with red oxide of mercury. The acetic acid may be separated by employing instead of chalk, as recommended by Döbereiner, carbonate of lead, to saturate with the assistance of heat; the acid liquid passing over in distillation, and separating by crystallization the formate of lead which is less soluble than the acetate, which dissolves easily. The formate is distilled with sulphuric acid previously diluted with its weight of water, and pure concentrated formic acid is thus obtained possessing an acid and agreeable odour.

Malic Acid.—Liebig recommends (*Poggendorff Ann.* xxviii.) the following process for obtaining this acid. Add carbonate of lime or some other alkaline carbonate to the boiled and filtered juice of the service tree till it is neutralized. Mix the neutral solution with nitrate of lead until precipitation ceases, and allow the liquid to remain in a warm place some days. During this time the flocky precipitate is converted into yellowish white needles. Acetate of lead may be employed in place of the nitrate; but a quantity of colouring matter is thus precipitated. The impure malate of lead is now to be boiled after washing with dilute sulphuric acid till it loses its granular appearance. To the thick matter, which contains sulphate of lead, sulphuric acid, malic acid, colouring matter, and other acids, a solution of sulphuret of barium is now to be added in small portions. The clear solution will now be filtered, saturated with sulphuret of barium and carbonate of barytes, and heated to the boiling point. Tartrate or citrate of barytes remains undissolved. The pure malic acid is obtained when the barytes is saturated with dilute sulphuric acid. If any barytes should remain in solution, the addition of a little spirit of wine will separate it.

By analyzing the malate of silver organically he ascertained the constituents of malic acid to be

Carbon	41·47
Hydrogen	3·51
Oxygen	55·02
	100·00

M. Jules Gay Lussac found in 1832, the composition of citric acid,

Carbon	42·05
Hydrogen	3·57
Oxygen	54·38
	100·00

Hence, if these analyses are correct, we have the composition of each represented by

4 atoms carbon . .	0·25
2 atoms hydrogen .	3
4 atoms oxygen . .	4
	7·25

and their formula is $4\,O + 4\,C + 2\,H$.

Malate of silver may be obtained by mixing nitrate of silver and malate of ammonia. It is a white granular precipitate, becoming yellow by drying, and consists of 66·53 oxide of silver, and 33·47 malic acid. It dissolves in hot water, and metallic silver precipitates on cooling.

Malate of zinc consists of oxide 37·75, and 62·25 of acid.

The crystallized salt has 3 atoms of water, which are driven off at 240°.

Malate of magnesia is formed of 23·45 magnesia, and 76·55 acid.

Malate of barytes, when formed from a solution of a malate is deposited by evaporation, in the form of a white crust, which is insoluble in cold and hot water, but readily on the addition of a drop of nitric acid. It consists of 56·441 barytes, and 43·559 malic acid.

Paramalic Acid.—Winckler described an acid under the name of *fumaric* acid, (*Jahresbericht* 247,) which M. Demarcay has shewn (*An. de Chim.* lvi. 429,) to be paramalic acid.

It is obtained from the juice of the *fumaria officinalis*, by treating it with animal charcoal, and precipitating by acetate of lead. The precipitate being washed, and a little water added, it is to be decomposed by sulphuretted hydrogen. By filtration a clear liquor is obtained, from which crystals of paramalic acid are separated by evaporation. Hitherto this acid has only been obtained by the decomposition of malic acid. The paramalate of silver, when analyzed, afforded for the composition of the acid

Carbon	41·84
Hydrogen . . .	3·41
Oxygen	54·75
	100·00

It dissolves with difficulty in cold water, more readily in hot, and the solution affords by cooling arborizations. It has an acid, styptic taste, volatilizes, and is sublimed by heat; forms crystallizable salts with ammonia and lime. It has no smell, and dissolves in alcohol and ether. Nitric acid sp. gr. 1·4 dissolves it completely, and fine needles separate on cooling.

Pyrotartaric Acid.—This acid is prepared by distilling tartaric acid, between the temperatures 337° and 374°.

The liquid obtained is introduced into a glass retort, and distilled till it acquires the consistence of syrup; the receiver is then changed, and the distillation carried to dryness. The last liquid which comes over is exposed to a severe cold, or to spontaneous evaporation in vacuo. Yellow crystals separate, which are pressed between blotting paper and again re-dissolved in water. On cooling, crystals of pure pyrotartaric acid are deposited. An analysis of this acid afforded

Carbon	52·11
Hydrogen . . .	5·30
Oxygen	42·59
	100·00

This acid is white, destitute of smell, very soluble in water and alcohol, with a taste resembling tartaric acid. It melts at 212, and boils at 370°. Acetate of lead precipitates it; the white product is insoluble in water, but very soluble in an excess of acetate. Pyrotartrate of potash, when poured into a solution of the proto-nitrate of mercury, produces a copious white precipitate, and forms with persulphate of iron a yellow precipitate, soluble in twice its weight of water; with sulphate of copper a green product which requires nearly the same quantity of water to dissolve it.

Pure benzoic acid may be procured, according to Righini, by dissolving the acid in four or five times its weight of sulphuric acid diluted with six parts of water, adding during the ebullition, a small portion of animal charcoal, and filtering. On cooling the acid separates in crystals. This process may be repeated if the crystals are not properly formed, and there is any smell. To obtain the crystals in perfect purity, they may be dissolved in alcohol, and the solution exposed in a subliming apparatus on the sand-bath, the heat being applied in such a manner that the alcohol alone is volatilized. The acid is thus obtained in long needles, perfectly white and destitute of smell. (*Ann. de Chim.* lvi. 444.)

Sulphobenzoic Acid.—This acid is formed by adding benzoin to sulphuric acid as long as any of it is taken up, allowing the flask to cool occasionally during the decomposition. (*Poggendorff*, xxxi.) By dissolving the acid in water, a peculiar substance separates, which, from its properties, Mitscherlich terms a sulpho-benzoide. The acid is saturated with carbonate of barytes, and the solution being filtered and mixed with sulphated protoxide of copper, large crystals of sulpho-benzoate of copper are obtained.

The sulpho-benzoates of zinc, protoxide of iron, silver, potash, soda, ammonia, and many other salts, crystallize well. The copper may be removed by sulphuretted hydrogen when the acid evaporated to the consistence of a syrup, assumes a crystalline appearance, and is decomposed by a strong heat. Sulpho-benzoate of copper may be exposed to a temperature of 220° (328° F) without undergoing decomposition, or affording a precipitation with solution of barytes. Anhydrous sulpho-benzoate of copper, analyzed by oxide of copper, yielded

Carbon	38·58
Hydrogen	2·62
Sulphur	16·94
Oxygen	21·03
Protoxide of copper	20·84
	100·02

The acid may be considered therefore as composed of one atom benzine and two atoms sulphuric acid.

SALTS.

Double salt of chloride of calcium, and oxalate of lime. According to Julius Fritzché, when oxalate of lime is dissolved in warm concentrated muriatic acid, on cooling a double salt of muriate of lime and oxalate of lime crystallizes. By pressing the crystals on paper the free acid may be taken up. and on placing them in water the muriate of lime dissolves and the oxalate of lime remains. The latter, after heating and solution in nitric acid, affords no precipitate, or merely a slight opalesence with nitrate of silver, and the solution gives no trace of oxalate of lime by ammonia.

This presents an easy method of analyzing the salt, by digesting it in a platinum capsule, filtering, and then precipitating the lime from the filtered solution by oxalate of ammonia. 2·563 grm. of the double salt gave 0·707 carbonate of lime from the residue, treated with water and 0·705 carbonate of lime from the portion dissolved in water. The salt consists of

Oxalate of lime - - - - - -	0·904
Chloride of Calcium - - - -	0·778
Water - - - - - - - - - -	0·881
	2·563

Double salt of chloride of calcium and acetate of lime. (*Pog. Ann.* xxviii. 21.) The combination of chloride of calcium with acetate of lime is easily obtained by dissolving small portions of both in water, and allowing the solution to evaporate. The double salt separates in large crystals. It is very soluble in water. Analyzed by oxalate of ammonia and nitrate of silver the constituents were

Acetate of lime - - - - -	0·711
Chloride of calcium - - -	0·500
Water - - - - - - - - -	0·789
	2·563

Sulphated Protoxide of Iron, and Chloride of Iron.—Bonsdorff has shewn, (*Poggendorff*, xxxi.) 1. That sulphate of iron may be obtained completely free from peroxide, by rendering, before crystallization, the solution acid, which has been made neutral by boiling.

2. That this salt, moderately dry or moist, is not altered by exposure to the air; but in dry air, or in a temperature of 104° F, in the course of time it gradually decomposes.

3. There are three varieties of vitriol, the first greenish blue, formed from an acid solution free from peroxide; the second dirty green, from a neutral solution without peroxide; and the last emerald green, from a solution impregnated with peroxide salt.

4. Chloride of iron may be obtained pure by rendering the neutral solution slightly acid by means of muriatic acid, and drying the crystals in a temperature between 86° and 104° F, mixed in a close vessel with a little chloride. At a temperature of 122°, and in dry air, the chloride falls to a white powder.

5. The primitive form of the chloride of iron is an oblique rhombic prism, and its atomic composition 1 atom chloride of iron and 4 atoms water.

Solubility of Bitartrate of Potash.—Brandes and Wardenburg have made experiments upon the solubility of this salt, and have found that at 212° F, 100 parts of water dissolve 6·68 parts of the salt.

100 parts water at		167°	dissolve	4·55
,,	,,	199°	,,	2·64
,,	,,	75°	,,	1·12
,,	,,	66°	,,	0·49

The method of experiment was to allow a solution, saturated at a high temperature, to cool down to the requisite point, (*Annalen der Pharmacie* i. 7.)

To be continued.

ARTICLE V.

On a deposit of recent Marine Shells, at Dalmuir, Dumbartonshire. By THOMAS THOMSON, Esq.

THE coal formation of the South of Scotland, which extends from the firth of Forth to the firth of Clyde, is closed towards the west by the Kilpatrick hills, an extensive greenstone chain which terminates in the Clyde, by the rock upon which Dunglass Castle, the termination of the Roman wall, is built. On the south side of the Clyde the coal field extends a little further, but there also it is intercepted by a range of greenstone and porphyry rocks, constituting the hills to the south of Greenock. To the west of the Kilpatrick hills, on the north side of the river, we find the beautiful white or reddish but non-fossiliferous sandstone of the neighbourhood of Dumbarton and Helensburgh, and in the vicinity of the latter place there is also found a vast quantity of red sandstone conglomerate, which there rests immediately on the clay-slate. This is the same conglomerate which is found on the south side of the river below Greenock, as well as in the island of Arran, and along the coast of the county of Ayr, and at Campbeltown in the Mull of Cantire. In all which places this conglomerate occupies a stripe of land adjoining the seacoast, while the interior of the country consists, about Greenock of greenstone, about Helensburgh and in Arran of clay-slate, and in Ayrshire of the coal beds.

The rocks in the neighbourhood of Glasgow are in many places covered with alluvial deposits, the nature of which varies very much in different places. In some parts of the immediate neighbourhood of this city, we find low hills of a thick miry clay, full of water-worn stones, and quite destitute of fossils. In others, and particularly under Glasgow itself, there occurs a deposit of very pure sand, of considerable thickness, rising in one or two places to a considerable elevation. This arenaceous deposit would appear to extend to a considerable distance, since the red conglomerate in the neighbourhood of Helensburgh, at the distance of twenty-six miles from Glasgow, is also covered with a very fine sand to the depth of eight or ten feet, in which shells are said to have been found during the digging of the foundations of Roseneath Castle. Here, however, there is also interposed between the sand and the secondary rocks, a bed of stiff clay very similar to the clay about Glasgow, by the position of which we may perhaps conclude, from analogy, that the corresponding clay at Glasgow is below the sand, and though no distinct section has there been obtained, yet the more frequent occurrence of the arenaceous beds might perhaps lead us to the same conclusion.

In the neighbourhood of Dalmuir, about 8½ miles from Glasgow, a section of the sand deposit is exposed by a small stream known by the name of Dalmuir burn. A few years ago, the proprietor of that part of the country found it convenient to alter the course of this stream. During the formation of the new course a great deal of sand was cut away, and in one particular place the workmen were surprized to find that they were digging through a mass of shells. The extent of the spot in which the shells are found is so limited that it would probably have remained unknown had not the overseer of Mr. Dunn's estate been kind enough to point it out to me when I was in that neighbourhood collecting fossils from the shale beds connected with the coal.

The locality in which the fossils are exposed is situated on the banks of the Dalmuir burn, about 100 yards above the bridge by which the road from Glasgow to Dumbarton crosses it, and about a mile from the Clyde. The current of the stream is not very rapid, so that the bed of shells is probably not more than 20 feet above the level of the Clyde, which at that place is sensibly salt at high water. The breadth of the channel of the stream at this place is about 14 feet, and the depth of the banks is about 2½ feet. The sandy deposit appears to extend on both sides of the stream, upwards and downwards without alteration, but the fossils are confined to a circular or rather elliptical space, the breadth of which (across the stream) is about twenty-five feet, while its length is only about 15 feet. The deposit extends back from each bank only about 6 feet, so that more than one half of the whole mass has been cut away during the change of the course of the rivulet. The whole depth of the bed, as it exists at present, is about 2½ feet, but I am informed by the overseer upon the estate, who superintended the workmen during their operations, that after the soil had been removed, ten or twelve feet of earth full of sand was carried away, so that the depth of the bed in its original state must have been 12 or 14 feet.

The number of species which have been already collected in the situation described amount to about thirty.

I have been greatly indebted to Mr. Sowerby for his assistance in determining their names.

I. Echinus Esculentus.

Shells.

1. Balanus costatus
2. Mya truncata
3. Amphidesma Boysii
4. Saxicava rugosa
5. Tellina tenuis
6. Lucina flexuosa
7. Cyprina vulgaris *(probably)*
8. Cardium edule
9. Nucula minuta
10. Astarte minima
11. Anomia ephyppium
12. Mytilus edulis
13. Modiola albicostata
14. Pecten Islandicus
15. ——— pusio
16. Lottia parva *(Patella p Montag.)*

17* Fissurella Noachina *(Cemoria Flemingii, Leach MSS.)*
18. Helix levigata (*Montag.*)
19. Velutina communis
20. Natica glaucinoides
21. Littorina vulgaris
22. Trochus cinerarius
23. Margarita ——?
24. Rissoa —— ?
25. Lacuna vincta
26. Fusus Bamffius
27. —— lamellosus
28. —— ——— ?
29. Buccinum undatum
30. ——— striatum NS.?

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* The Fissurella Noachina has been found at Oban, Argyleshire, by Mr. Lowe, See Zoolog. Journ. Mr. Sowerby has compared a specimen from Dalmuir with

The last shell was marked by Mr. Sowerby as a new species of Buccinum. Although approaching B. undatum, it may be distinguished by the following characters:—

1. Buccinum *striatum*.

B. Anfractibus longitudinaliter undatis, transversim striatis, parum convexis, costis longitudinalibus fere rectis.

This buccinum approaches nearly to B. undatum, from which, however, it is easily distinguishable by several particulars.

If B. undatum be examined with a microscope, it will be found that the transverse ridges are elevated, broad and distant, and there is between each of these ridges, in the upper whorls, a narrower and less elevated ridge, and in the lower or newer part of the shell, generally about three. Now, in B. striatum, the ridges are so flat that the shell may much more properly be said to be spirally striated, than covered with transverse ridges. The whorls in the new shell are also much flatter than in B. undatum, and the longitudinal undations which in that shell are considerably concave towards the mouth of the shell, are here almost quite strait. F. lamellosus possesses the following characters:

2. Fusus lamellosus.

F. oblongus, longitudinaliter costatus, parte superiore anfractuum subangulato; anfractibus 10 costatis, costis elevatis ad aperturam testae, concavis, supra subspinosis; apertura ovali, cauda breviori quam apertura, laté canaliculatâ, parum reflexâ.

This pretty little fusus is about 5 lines in length, and 2½ in breadth, being more minute than recent specimens. Each whorl is furnished with ten longitudinal ribs, and the interstices are perfectly smooth. The ribs are considerably elevated and acute, and are rather prominent on the upper part of the whorl, which is slightly angled. There they rise so as to form small teeth, beyond which they are continued obliquely along the flat part of the whorl, quite to the suture. The canal is open, and rather wide, but not so

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the Cemoria Flemingii of Leach in the British Museum, and has ascertained their identity. The Fusus lamellosus, is the Murex lamellosus of Lamark, and a remarkable circumstance connected with the history of this shell is, that hitherto it has only been found in the South Sea, at the Falkland Islands, with a specimen from which locality I have been favoured by Mr. Sowerby.—Edit.

long as the aperture. It is turned to the left, and is a little reflexed.

The shells which have been found in the Dalmuir sand have in general lost all colour, and become of a dull yellowish white, but otherwise, though brittle, they are in a state of beautiful preservation. They appear to be all natives of the British seas, with the exception of the F. lamellosus, which has only been observed about the Straits of Magellan, and Natica glaucinoides, which is a crag fossil. But the relative proportions in which they occur by no means agree with that in which our seas produce them. On the contrary, in general those which are most common in the sea, appear to be rarest there, while those which are found at Dalmuir in the greatest profusion are mostly rare in the sea. For example, of the Mya truncata, which is one of the commonest shells in the Firth of Clyde, only one imperfect specimen has been found at this place, while Fusus Bamffius, Lacuna vincta, Fissurella Noachina, and Astarte minima, none of which are common shells, together with Natica glaucinoides, which is a crag fossil, are very common at Dalmuir. Cardium edule is extremely scarce, and Mytilus edulis is equally so, and Ostrea edulis has never been met with, while on the other hand, Pecten islandicus, and Patella parva, are very common. From these facts it is evident that the deposit cannot have taken place while the inhabitants of the Firth of Clyde were in every way the same as they are at present.

The shells which have been assembled in this confined spot, and buried in sand in this extraordinary manner, appear to have been collected from very different situations. The Nucula minuta, and the Velutina, inhabit deep water; the Buccina, and the Astarte, frequent the sands about low water, in which the Mya truncata and the Cardium edule bury themselves; while the Mytilus and the Modiola attach themselves to rocks in deep water, and the Littorina (and probably the Natica) frequent those rocks which are alternately covered and laid bare by the ebbing and flowing of the tide.

It is remarkable, and is a circumstance which adds to the extraordinary nature of this deposit, that the sand in the immediate neighbourhood of the fossils is quite destitute of any traces of shells. Few of the shells which it contains have been previously found fossil, and therefore it appears probable, that if not considered as belonging to the recent period, it must be referred to a very late tertiary era, at a time when all the low lands on the banks of the Clyde, at least as far up as Glasgow, have been covered by an arm of the sea.

Article VI.

Account of some fossil Crustacea which occur in the Coal formation. By John Scouler, F. L. S. Lecturer on Mineralogy to the Royal Dublin Society.

The recent discovery of the remains of fishes and reptiles in the coal formation of Burdiehouse, rendered it extremely probable that similar relicts might be detected in the extensive carboniferous strata of the west of Scotland. With this expectation, different quarries in the vicinity of Glasgow were examined, and although but a short time could be devoted to the investigation, the research was not altogether unsuccessful. The remains of fishes, (Sauroid fishes of Agassiz) were found in several localities, and in one place beds of limestone occur, which abound in impressions of ferns and entomostraca.

This limestone is situated about a mile to the east of Paisley, and was first pointed out to me by Mr. Murray of the Glasgow Botanic Garden. This rock is distinct from, and probably reposes on the true carboniferous limestone, but as only a small patch of it is exposed, the greater part being covered by the soil, it was impossible to trace its relations with the subjacent strata. This limestone is of an extremely compact nature, with little plates of calcareous spar disseminated through its substance. It readily splits into flags of variable thickness, which are sometimes made up of a multitude of extremely thin layers, indicating that the whole stratum has been formed by the gradual and tranquil deposition of transported matters. The organic matters differ widely from those which we observe in the carboniferous limestone. I could detect no Productae, nor any fragments of corals, or stems of crinoid animals, nor in short, any decidedly massive production. Instead of these, on splitting up the rock we observe impressions of ferns of great rarity and beauty, the remains of entomostraca which are of gigantic size, when compared with the analogous species which still abound in our lakes and pools. Two species belonging to a new genus were obtained, and the number might have been greatly increased, had not the hardness of the rock rendered the extraction of the specimens a difficult task. The following is a short description of these remains:

1. *Argas testudineus*, (Fig. 1.) The shell is rounded and deeply emarginate at its anterior extremity, and surrounded by a thinner margin; the epidermis is covered with numerous elevated lines. Two ridges extend through the whole length of the shell, one on each side, their position being intermediate between the margin and the middle line. The tail (abdomen) is articulated, but the number of joints is uncertain, perhaps seven or eight, and it terminates in three appendices (respiratory organs?) as is the case in the recent genus Apus. In our specimen these appendices are of equal length, and have a similar form, while in the genus Apus, the middle one is the shortest, and its form is different from that of the others. No vestiges of eyes, antennae or organs of locomotion could be observed. The length of the specimen from the anterior margin of the shell to the extremity of the tail is $2\frac{3}{10}$ inches. Length of the shell $1\frac{1}{2}$ inch. Breadth $1\frac{1}{5}$ inch. The shell has a considerable resemblance both in size and form to the dorsal shell of some of the fresh water turtles, and hence the appellation, which we have ventured to give to the species.

2. *Argas tricornis*, (Fig. 2.) The shell is elliptical but truncated anteriorly, and much more depressed than in the preceding species, and a single ridge runs in the direction of the middle line. At the anterior extremity of the shell there are three acute triangular processes, one at each angle of the shell and one in the middle. Two grooved lines extend around the circumference of the shell, the one internal, separating the margin or thin portion from the rest of the shell, and the other line external, dividing the margin into two distinct parts. The posterior extremity of the shell is very indistinct, and the number of joints in the

tail could not be ascertained. Length of the specimen 4⅘ inches. Length of the shell 3 inches. Breadth 1½ inch. Length of the tail about 1½ inch.

This specimen as will be seen by an inspection of the figure is greatly distorted, the shell has been curved, and the tail or abdomen almost separated from the body. The species is, however, completely distinct from the preceding. The three processes at the anterior extremity of the shell, and the single ridge running along its middle, are sufficient to distinguish it.

That these animals were crustaceous and belonged to the division *entomostraca*, is sufficiently apparent from a mere inspection of the figures. That they do not belong to any genus at present existing, may also be admitted. It is true, that the characters not only of the genus, but also of the higher groups of crustaceous animals, are chiefly taken from the arrangement and number of masticatory organs, feet and antennae, and that all these parts are wanting in our specimens. Still we have sufficient data for distinguishing them from all the genera hitherto described.

In the *Limuli* the tail consists of a single ensiform appendix, and the shell is divided into two distinct sections, characters which the fossil species do not possess. Our fossil species belong to Latreille's class of Branchiopodes which comprehends the genera Apus, Cyclops, &c., but as these genera are distinguished by the number of eyes, we cannot apply these characters to the fossils where every vestige of such parts is lost. Our specimens are, however, nearly allied to the two genera which have been mentioned. They differ from Cyclops, in having three caudal appendices, while in that species there are but two. In the fossil genus the shell consists of a single piece, while that of Cyclops is composed of several sections. In the genus Apus the middle caudal appendix is much shorter than the lateral ones, and of a different form, while in the fossil the three setae are all firm, and the skull has also a different form in the two genera. We may, therefore, consider these *entomostraca*, as constituting a new genus, which we have named *Argas*, in conformity with the terms, Cyclops, Monoculus, and Polyphemus.

Entomostraca have hitherto been considered of rare occurrence in a fossil state. In the work of Desmarest on fossil crustacea, only two species are described, the *Limulus Walchii* found in the bituminous limestone of Solenhofen and Pappenheim, and the *Cypris faba* abounding in the tertiary limestone of several places in France. To these may be added another species of *Cypris* found in the Wealden rocks of England and figured by Mr. Mantel. They appear to be more frequent in the carboniferous strata than is generally suspected, as in addition to the two species described in this paper, I have described and figured a much more gigantic specimen (belonging to a different genus) which was found near Bathgate.* The species to which I have alluded was at least a foot in length, and the specimen described measured nine inches, although a considerable part of the posterior extremity was wanting.

The animals of the family *entomostraca* are cheifly inhabitants of fresh water, although several species are found in saline marshes and on our shores. With the exception of the *Limuli* they are in general extremely minute, and can only be studied by the aid of the microscope. They abound in every pool, and may be collected in hundreds. Many of them are parasitic, and suck the juices of tadpoles and fishes; while others swim freely about. The natural history of these animals is very remarkable on account of the numerous metamorphoses which they undergo, so that during different stages of developement they have but little resemblance to the mature individuals. They often change their skin, and at each change can re-produce any organs they may have lost, and a single fecundation suffices for the females for several generations.

If we omit the consideration of magnitude, there appears to be a striking analogy between the vegetable and animal inhabitants of our pools and lakes, and those of the coal formation. The little *equiseta* seldom attaining to the height of two feet, are the representatives of the ancient *calamites* whose height exceeded 15 feet; and the diminutive ferns and mosses may be compared with the arborescent *ferns* and *lycopodiae* of the coal, while the little *entomostraca* of our lakes are similar in structure, though far inferior in size to the species which formerly existed in the same places; and the same remark applies to the fishes.

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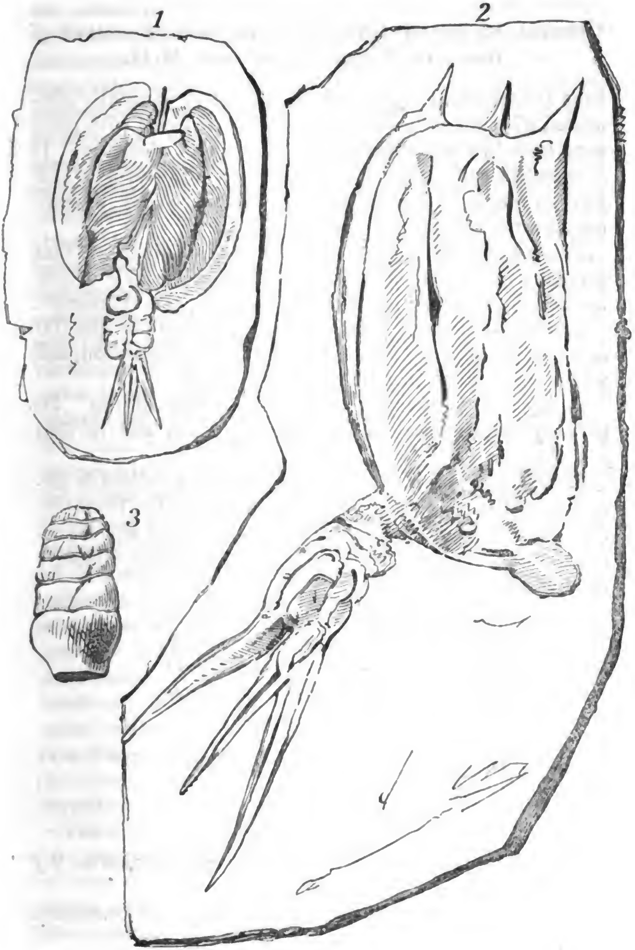
* Edinburgh Journal of Natural and Geographical Science, vol. iii. p. 352.

Besides the remains already described, the examination of other places afforded different specimens. Although unsuccessful in the search for the teeth of fishes, others were more fortunate. Two teeth of Sauroid fishes were found by my young friends the Masters Brown, in shale at the sandstone quarry near Woodside. The sandstone is covered by alternate beds of sandstone, coal, and shale, and it is in the last named substance that the teeth are found. Encouraged by the success of the gentlemen I have mentioned, I repeatedly examined the shale of this place, but unsuccessfully, for the only specimen which I procured was the spine of the fin of some fish resembling the bony spine of the dorsal and pectoral fins of some *Siluri*. It was about 4 inches in length. A sauroid tooth was also found in the neighbourhood of Campsie, and presented to the Andersonian Museum at Glasgow by Mr. Graham.

Remains of fishes also occur in the parish of East Kilbride, as had long ago been indicated by Ure in his interesting work. In that parish the upper part of the limestone is extremely rich in the remains of marine animals, such as *entrochi*, *ammonites*, *productae*, *reteporae*, *turbinoliae*, *&c.* In one place whose name I do not know, there are a number of beds of clay and shale resting upon the carboniferous limestone, which afford a different kind of organic remains. In this situation we find the remains of fishes, coprolites, and crustacea. The coprolites are as distinct as those figured by Mr. Mantel from specimens found in the chalk, and are spirally twisted as is the case in those which are observed in more recent formations.

No teeth were found, but one bone of a fish was procured which I have communicated to M. Agassiz, whose labours have so much illustrated this branch of natural history.

Fig. 1. Argas testudineus.
2. Argas tricornis.
3. Coprolite from East Kilbride.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Article VII.

Chemical Analysis of Crucilite, a new form of peroxide of Iron. By Robert D. Thomson, M. D.

Iron is such an important metal, that every particular connected with its natural history must be received with pleasure, both by the manufacturer and the man of science. It is from this consideration that I venture to describe a new form in which I have met with it occurring native, in combination with its saturating dose of oxygen.

Previous to doing so, however, it may be observed, that there are four principal states in which the peroxide of iron has been hitherto found, which it may be proper to enumerate.

1. Anhydrous peroxide of iron, or anhydrate or specular iron ore, the primary form of which is a rhombohedron, and whose composition may be represented by f.

2. Hydrous peroxide of iron, or perhydrate of iron. Its primary form is a scalene four-sided pyramid, and its sign $f + Aq$.

3. Dihydrate of iron, which has not been noticed in mineralogical books, but has been examined by Dr. Thomson. A massy specimen from his cabinet which I analyzed possessed a spec. grav. of 4·016, dissolved with some difficulty in aqua regia, and consisted of

Peroxide of iron - - - -	77·48
Lime - - - - - - - - -	6·41
Silica - - - - - - - - -	6·00
Peroxide of manganese - -	1·50
Water - - - - - - - -	8·50
	99·89

Now this is equivalent to

Peroxide of iron 2 atoms
Water - - - 1 atom

and the formula which expresses this composition is $2f + Aq$.

4. Magnetic iron ore, consisting of 1 atom of protoxide and 2 atoms peroxide of iron.

During the course of last year, the variety which has been already alluded to was brought from Ireland by Mr. Doran, the mineral dealer. It was seated in sandstone, the crystals being arranged in the form of a St. Andrew's cross. On measuring the angles at which these crystals crossed each other, I found them to be of the value of 60° and 120°. The crystals themselves were oblique four-sided prisms, the acute angle measuring 59¾°, but so near 60° that I have no hesitation in considering the latter number as expressing its true size: the obtuse angle measuring nearly 120° by the common goniometer. From the cruciform disposition of the crystals, it is proposed to term the mineral *crucilite.*

Before the blowpipe it behaves like peroxide of iron. The crystals are red externally, occasioned probably by the partial absorption of carbonic acid, which has converted them superficially into a similar combination with rust which is soft and pulverulent. Internally they are black, and possess the metallic lustre; streak black shining; cleavage parallel to the faces of the crystals; fracture uneven; possesses no action on the magnet; sp. grav. 3·579, which is probably below the true density, as the portion with which this number was determined, was decomposed. 25 gr. of the crystals reduced to powder were digested in nitric acid, and a little muriatic acid was added to increase the action which was slow with the former agent alone; a small portion of silicious looking matter remained, which was edulcorated, and its weight noted. After ignition it assumed a yellowish colour, and dispersed through it minute scales of mica could be distinctly detected, and its appearance was precisely similar to the sandstone in which the crystals were seated. It was insoluble in boiling acid, and when fused with carbonate of soda, alumina and silica were separated, while some micaceous scales remained undecomposed. It had obviously, therefore, been mechanically attached to the mineral, although care had been taken to separate the crystals as entirely as possible from the native rock.

The liquid which was separated from this insoluble residue was precipitated by ammonia. A copious precipitation of iron ensued, which, after being well washed with hot water, was dissolved off the filter with dilute muriatic acid. The solution was boiled with caustic soda, which threw down the iron. This precipitate was again dissolved in acid, and thrown down by caustic ammonia. The supernatant liquid was saturated and precipitated by carbonate of ammonia; the resulting precipitate affording, with sulphuric acid and potash, crystals of alum. The liquid which passed through the filter from the iron and alumina, afforded a precipitation on the addition of oxalate of ammonia, and afterwards magnesia was procured from it by the usual process. A portion of the iron precipitate was dissolved in acid, and to the neutral solution, benzoic acid was added, which threw down the iron. The solution to which some carbonate of soda was added was evaporated to dryness. No residue ensued on the addition of water, indicating the absence of manganese.

The iron precipitate, when dissolved, afforded powerful indications of the presence of that metal, by prussiate of potash. In the solid state it was not affected by the magnet. The results of the analyses are:—

Peroxide of iron	81·666
Alumina	6·866
Silicious matter	6·000
Lime	2·000
Magnesia	0·468
Loss, probably water	3·000
	100·000

The quantity of mineral which could be afforded for the purposes of analysis was, however, too small to determine directly whether water was present as a constituent. The relative proportion of the ingredients are

Peroxide of iron	5½ atoms
Alumina	1 atom
Silica	1 atom

but as it is not easy to conceive distinctly how such a combination can exist, I am rather inclined to adopt the opinion that the alumina and silica are mechanically mixed with the oxide of iron.

Article VIII.

Traité Experimental de electricite, &c. Par M. Becquerel. Tome II. Paris, 1834.

The appearance of this volume cannot but be regarded by every cultivator of science as a great boon. The author has undertaken to collect, from scattered sources, the numerous experiments which have recently been performed so abundantly in elucidation of electricity, and such a laudable enterprize deserves to be encouraged. To the Englishman, this work cannot be perused without pleasure, because he will find in it a view of the labours of his countrymen who are taking the lead in this branch of Science, and who have essentially contributed to increase to three large volumes what but a few years ago was usually comprised in a few pages.

The first book of the present volume of Becquerel's works is devoted to the consideration of Electrical Statics; the second book treats of Magnetism, and the third of Electro-dynamics.

1. There is an important question which it is a great object to determine, in reference to the developement of electrity by friction. Whether electrical phenomena derive their origin from the modifications which the ethereal substance supposed to surround the atoms of matter undergoes, or from an imponderable fluid which exists in the interstitial spaces of these atoms. Now, although the first be the most probable of these suppositions, the facts hitherto observed are insufficient to resolve the question.

Another interesting subject of inquiry is the relation existing between conductors and non-conductors of electricity, for all the elements of bodies, when in solution, are provided with the property of obeying the action of electrical forces. There are no data, however, by which this question can be determined.

The author describes minutely electroscopes, or those instruments which are necessary for detecting small quantities of free electricity in bodies, and electrometers, a contrivance by which an approximation can be reached of the charge of a machine, or of an electrical battery. For appreciating the presence of feeble electrical currents, galvanometers, or multiplicators, are employed, in the adaptation of which, M. Colladon has made some useful improvements. Under this head, several tables of electrical intensities are given, which are of considerable value.

1. The influence of heat upon the disengagement of electricity forms that part of the science which has been termed thermo-electricity. Cumming, Sturgeon, and others, have prosecuted the investigation of this subject with great vigour. It has been observed that during the conduction of heat through a bar of metal the electricity is decomposed, and united in a manner analogous to the propagation of heat through bodies, and that, in a ring of bismuth or antimony, if one half is cooled, whilst the other is heated, an electrical current is instantly produced. Sturgeon has observed some curious facts in reference to this point, but has not been able to deduce any general conclusion from his experiments, save that the developements of the currents in the masses of bismuth and antimony of different forms, of which all the portions are not endued with the same temperature, are to be attributed to the crystalline arrangements which the atoms assume, for if a little tin is added to these metals the thermo-electrical property is lost. Sturgeon has observed that all metals possess analogous thermo-electric properties, provided the experiments be made on considerable masses.

When the ring is constituted of different metals, or when a plate of copper is soldered to the extremities of a bismuth or antimony cylinder, if heat be applied to one of the solderings, an electric current is established which proceeds from the bismuth to the copper, or from the copper to the antimony, according to the apparatus employed. When circuits are formed with wires of different metals, and the temperature of one of the solderings is elevated successively, currents are produced which indicate an arrangement of the metals according to have thermo-electric properties to be bismuth, platinum, lead, tin, copper, gold, silver, zinc, iron, and antimony, which is analogous to the order of their specific heats. In most of the metallic circuits the intensity of the current is in proportion to the temperature up to 40° at least.

Some minerals exhibit thermo-electrical properties. In the tourmaline these may be excited by slow heating and cooling, or by rapid heating and cooling. These vary, according to Becquerel, however, in proportion to the size of the crystals, as the smallest tourmalines assume a very strong polarity by feeble changes of temperature, while Mr. Forbes has concluded from his experiments, that the size of the section of the tourmaline employed has so much influence that where the difference is considerable the largest crystal always is most powerful. A crystal 1¼ inch in length possessed an intensity of 45°. When broken at ¼ of its length, the two portions being heated and again subjected to experiment, the largest portion indicated a deviation of 47° and the smallest 43°. Mr. Forbes conceives that we may infer from analogy that the intensity increases with the diameter of the tourmaline, but that we are still ignorant if the length of the crystal has any influence on the electrical properties. Canton, Brard, and Haüy, have observed similar properties in other minerals, and Sir David Brewster has announced them in above 35 bodies, consisting of minerals and salts. He employed for detecting the pyro-electricity small portions of the internal membrane of the *arundo phragmites*, which, when dry, are extremely light, and adhere to the crystal which has been heated to the number of 1, 2, and 3. Becquerel considers this test insufficient, and affirms that the only criterion by which we can decide upon electrical influence is, first, by the attraction of light bodies presented to the electricity, and second, their repulsion succeeding the contact.

Heat diminishes the electrical conduction of metals, while it increases this property in glass, gumlac, and other bad conductors, but in what way has not been clearly made out.

2. The author enters into the consideration of the electricity produced by chemical action, as when one body combines with another, the substance acting the part of the acid becomes positively electrical, while the alkali is negative; when one solution acts upon another; when metals react upon acids or saline solutions; when two different metals react upon one or more liquids, for instance, if a plate of copper and one of zinc, communicating each with one of the ends of the wire of a multiplier, be immersed in a solution of sulphate of zinc, the copper becomes positive and the zinc negative. 3. A review is then taken of the experiments of Pouillet, in reference to the developement of of electricity in combustion. Charcoal, when burned, was found, by that experimenter, to emit positive electricity in the carbonic acid,

negative in the charcoal, and the same effect was exhibited in the combination of hydrogen with oxygen, but a negative result was observed in the flame occasioned in the latter union. Becquerel shews, however, that this subject requires further elucidation. Water exhibits no sign of electricity when evaporation commences; but when it contains strontian or other bases, the vessel holding the solution becomes positive, and the vapour of the water negative.

A source of electricity analogous to that of chemical action is the decomposition of oxygenated water, or peroxide of hydrogen, a substance discovered by M. Thenard. All the metals, with the exception of iron, tin, antimony and tellurium, tend to induce the separation of the elements, and the phenomena dependent upon the contact of the metals, and the peroxide proceed from its decomposition and from the oxidation of the metal. When an oxide is brought in contact with the peroxide, for example oxide of silver, two phenomena occur, which give origin each to contrary currents which tend to destroy each other.

4. With regard to the electrical effects produced in capillary action, it appears that when muriatic acid acts upon spongy platinum, the latter is at first positive and then negative immediately after. The reverse occurs with nitric acid. It is obvious that acid is at first absorbed and gives rise to heat, which occasions thermo-electric effects; but the elevation of temperature is not the only cause of the phenomenon, for if the platinum is removed in the case of the nitric acid, although a new immersion produces no effect, by heating and re-immersion in the acid, the current proceeds from the acid to the spongy platinum, and continues in this direction until the temperature be equalized in all parts. The direction of the current is the same as that of a secondary current produced by concentrated acid. Hence, the first current proceeded from the action of the acid and platinum, but we are ignorant if it proceeds from a slight alteration which the platinum may experience from contact with the acid.

5. Electricity may be elicited from all bodies if properly isolated by pressure. Five substances thus pressed acquire opposite states. All vitreous crystallized substances such as sulphate of lime, fluor, spar, &c., when pressed on a disk of cork are electrified positively; while fruits such as the orange, under the same circumstances communicate to the cork an excess of electricity.

The disengagement of electricty by pressure is modified by several causes, as the conductibility of bodies and heat. The author describes minutely an apparatus for determining the intensity of the electricity developed by pressure, with which numerous trials have been made on different bodies. The result of these shew that the electrical intensity is proportional to the pressure, that is to say, that if the pressure is doubled the intensity is likewise double; at least this law holds good as far as a pressure of 10 Kilogrammes (22 lbs. 1 oz. 1 dr.)

In connexion with the effect of pressure, cleavage is noticed. When a plate of mica is rapidly cleaved in a dusk place, a feeble phosphoric light is observed. On examination each of the separated portions is found to possess an excess of opposite electricities.

6. Two opinions have been broached to explain the effect of electricity by friction, viz: that it is derived from the adaptation of the asperities of the surfaces rubbed upon each other, or from the reciprocal action of the atoms of bodies upon each other. In favour of the first opinion it is argued that the electrical excitement is great in proportion to the roughness of the bodies subjected to friction; and in support of the second the fact is brought forward, that if two plates of glass or marble are slid upon each other so as perfectly to cover each other's surfaces, they adhere powerfully to each other independently of atmospheric pressure, for the same result occurs in a vacuum. The author has performed a number of experiments for the purpose of settling this question, from which it appears that the disengagement of electricity seems to depend on the state of the division of the parts of bodies and of the rapidity of friction, and that the body whose parts undergo the most displacement has a tendency to produce negative electricty.

The causes which determine the disengagement of electricity in non-conductors are difficult of appreciation, but the state of their surfaces has a greater influence upon the nature of the electricity, than in the metals. Delarive conceived that all the metals when they are rubbed with wood, the hand, or cork, &c., become negatively electrical. Haüy has given the name Disthene to a crystallized mineral, whose surfaces have such an influence upon the nature of the electricity disengaged in the friction of bad conductors, that positive electricity is exhibited on certain faces, and negative on others, by the same friction, without any apparent distinction between them.

Friction in a great number of cases may give origin to chemical re-action, and electrical effects of chemical origin, have been sometimes attributed to purely physical causes. Becquerel is inclined to conclude, however, that although chemical action is the most influential agent in the production of electricity, yet, that in the present state of the science, it is not proper to abandon the theory of Volta, in regard to developement by contact. Faraday considers contact to have no influence.

7. Ampere was the first person who endeavoured to produce electrical currents by the influence of other currents, but he merely broached the fact, while Faraday following it out, has formed on it an important branch of electricity. To the power which electrical currents possess of exciting electricity, he has applied the term *induction,* the induced current, occasioned by the action of the inducing current being directed in a contrary direction. He has fully confirmed the idea of Ampere, that magnets may be considered as formed of electrical currents, turning round their molocules in a direction perpendicular to their axis.

The author, after considering the sources of electricity of which we have given an outline, proceeds to lay down the laws which regulate its action.

He explains the important law demonstrated by Coulomb, that the particles of electricity repel each other inversely as the square of the distance. Coulomb has shewn that the loss of electricity in the atmosphere is always proportional to the electrical density; and it follows, from the experiments of Lord Stanhope, that the density of the electricity of electrical atmospheres diminishes inversely as the square of the distance from the excited body. But, as the demonstration of Coulomb's law has been very clearly stated by Dr. Thomson in his work on electricity, which, as it contains a full and accurate description of electrical apparatus, and of most subjects contained in the remainder of Becquerel's book relating to electricity, we shall beg leave to refer to, as being more easily understood by the English reader, and proceed to the section on

II. *Magnetism.*—After treating of the general properties of magnetic needles, Becquerel proceeds to consider the earth's action upon magnets. He describes very particularly Pouillet's compass for determining the declination, and then brings forward some of the results obtained by its means. The determination of the resultant of the magnetic force of the globe is a point of importance, which is measured by the number of oscillations of the needle occurring in a given time, the needle acting in relation to the terrestrial magnetic force, as the pendulum in connexion with gravity. Coulomb has proved that in reference to the magnetic momentum, the number 1917·76 represents the force of torsion, which would be necessary to maintain the magnetic needle at 90°. The forces of torsion for the deviation of a small number of degrees being proportional to the angles or their signs, we have

$\frac{\textit{force of torsion}}{\text{sin. } 90^\circ} = 1917{\cdot}76$, but sin. $90^\circ\ 1 = 1$; then force of torsion 1917·76. He found also that the momentum of needles is nearly as the squares of the length of the threads of suspension.

2. The force of magnetic attraction and repulsion is inversely as the square of the distance.

3. The author then proceeds to explain the method of forming magnets, and describes particularly the application of Gilbert's discovery by Scoresby, by which the magnetic influence can be imparted to bars of iron without the aid of magnetized bodies. Two bars of steel are taken, 30 inches in length, with two other plate bars of steel 8 inches long and half an inch broad, and a long bar of iron, all of them destitute of magnetic power.

The large bar of iron is first struck in a vertical position, and then placed, without changing its direction, upon the steel bars which have also been struck. They are then struck upon each other. Each of the small bars, suspended vertically to the summit one of the large steel bars, is successively struck, and in a few minutes they acquire a considerable magnetic power. Two more of the small bars united by two small iron parallepepids are rubbed with the four bars, and are then replaced by two others, and these again by the two last. Each pair of bars being then treated for a certain space, and being changed after exposure to friction for a minute, is found completely saturated with magnetic fluid. This method of preparing magnets is not only more simple than those of the double touch of Mitchell and Canton, and of successive contact of Duhamel and Alpinus, but it increases considerably the magnetic intensity of the bar.

4. Kupffer has shewn, in regard to the effect of terrestrial magnetism upon bars not thoroughly magnetized, that a vertical magnetic bar has more force when the north pole is directed downward than in the opposite direction.

5. Quetelet has found that a single friction is sufficient to reverse the poles of a magnet, and place the bar in a contrary magnetic state, and that the influence which tends to bring the poles to their primary state is the most powerful, although, after a certain number of reversions this tendency diminishes.

6. Magnetic needles which are not too short possess directing powers with an equal diameter proportional to their lengths, provided their transverse section be always the same. It results from Coulomb's experiments, that *ceteris paribus* needles should possess no greater thickness than is necessary to prevent them from bending.

7. Mr. Barlow has succeeded in determining the law which regulates the action of iron upon magnetic needles as on board of ship, viz.: the tangents of deviation are proportional to the cubes of the diameters, or as the power $\frac{3}{2}$ of the surfaces, whatever be the solid contents. The magnetic force being as the surface, and the tangent of deviation $\frac{3}{2}$ of the surface, it follows that the square of the tangent of deviation varies directly as the cube of the force, or the tangent of deviation varies directly as the power $\frac{3}{2}$ of the force.

8. The experiments of Haldat tend to shew that in untwisting an iron wire which has been magnetized by torsion, its polarity is removed; and Nobili has almost proved that magnetism increases more in proportion to the degree of tempering than to the mass of the magnetic body.

9. Newton, in his optics, has stated that iron raised to a red heat is not magnetic, while Kircher has made an exactly opposite remark.

Barlow found the action of iron raised to a blood red heat very intense, but extinct at a white heat; between a red and white heat he observed that the action increases in proportion as the bar is raised above the needle, while at a low temperature the action of a bar of iron in the same circumstances goes on always diminishing. He heated bars of copper to an intense temperature, and on approaching the needle could detect no action. Hence, the heat does not act independent of the iron. He supposes that during the cooling of the bars the extremities where the cooling is most rapid become magnetic before the rest of the metal, giving rise to a complex action, but admits that this explanation is not sufficiently satisfactory. Coulomb obtained similar results; and Kupffer has demonstrated that the diurnal variations do not contribute to diminish the magnetic influence of the needle, but that the magnetic force of soft iron increases with the heat. Mr. Christie found that between the limits of 112° and 212° an increase of temperature produced an increase of force in the magnetic power of iron, which seems to argue against the idea that the action of the iron upon the needle proceeds from the polarity which is communicated to it by the earth.

10. Coulomb was the first who pointed out the nicest method of ascertaining the presence of magnetism in all bodies in nature,

by suspending them (after being cylindrically formed) by means of a thread, applying a needle, and judging of the magnetic force by the number and rapidity of the oscillations, and he extended this method to detecting small quantities of iron disseminated through greater masses of other metals. Biot employed it likewise to detect iron in minerals, as for instance, in two different species of mica, one from Siberia and the other from Zinwald, in Bohemia. The former executed 7 oscillations in 55 seconds, the latter 12 in the same time. The magnetic forces of each were as the squares of these numbers, or 49 to 144; considering these forces as proportional to the quantity of oxide of iron, the Zinwald mica should contain 20 per cent. of the oxide, and the other 6·8, which corresponds with the result of analysis. Haüy endeavoured to detect still smaller quantities of iron by a modification of this plan. By these means it has been ascertained that all bodies placed near very powerful magnets manifest feeble magnetic properties attributable to small quantities of iron which have not been detected by art. Arago has proved further that all bodies in the neighbourhood of a needle which oscillates, produce in it an action, the effect of which is to diminish the extent of the oscillations without diminishing their number. He found also that by causing a rotatory motion in a plate of copper, placed under a magnetic needle, that the needle was driven from the magnetic meridian at the commencement of the rotation, increasing in force proportionally to the rapidity. Prevost and Colladon deduced from their experiments that the angles of deviation, and not their signs, increase in proportion to the rapidity that the signs of the angles of deviation increase inversely with the power $2\frac{1}{3}$ of the distance.

Babbage and Herschel have announced that the law is not constant, and that it varies between the square aud the cube of the distance.

Barlow observed, that whatever be the direction of the axis of rotation, if the movement of the rotating body is directed towards the needle, the north pole of the latter is attracted; if the contrary, then the extremity is repulsed. If the needle be carried round the rotating body parallel to the axis, it has a tendency to arrange itself at right angles with it.

11. Electricity and magnetism although they agree in most respects differ apparently in this, that electricity penetrates into all substances, while magnetism only enters three bodies in a state of rest, viz. iron, cobalt and nickel. Poisson has endeavoured to reconcile this and the other facts with which we are acquainted in reference to this principle, by his theory. He conceives that we may represent a magnetic body, as a collection of magnetic parcels separated by spaces inaccessible to magnetism. The relation of the sum of all these parcels to the entire volume of the body which may be considered its density, in relation to magnetism, will be a fraction which will approach unity more or less in bodies of a different nature, and which ought to be given for each body in particular. He attributes all the magnetic phenomena to two imponderable fluids, influenced by general laws of equilibrium and motion, and which may exercise upon bodies, in consequence of the reciprocal action of their particles, pres-

sure which may be measured. The law of their attraction and repulsion is inversely as the square of the distance. His theory of the magnetic phenomena of rotation has been shaken by the discoveries of Faraday.

III. *Electro-dynamics.* 1. To Oersted we are indebted for the foundation of this branch of electricity. He demonstrated the action of electric currents upon the magnet, while Biot and Savart prosecuting the subject discovered the law which regulates this action at a distance, viz.: that the electro-dynamic force increases inversely as the simple distance. M. Savary applying the formulæ of Ampere to the experiments of Biot and Savart, has found that the total action of the wire was reciprocally proportional to the simple distance. M. Colladon first observed the action of the Leyden phial upon the needle. With a phial two feet square charged as strongly as possible, the deviation of the needle was 32°. Faraday has demonstrated further, that a continuous deviation of the magnetic needle in the multiplier may be obtained with the common electrical machine, provided time be allowed to enable the action to be produced, by causing the electricity to pass along imperfect conductors.

2. But one of the most important consequences from the discovery of the action of the electric fluid upon the magnet was the observation of M. Arago, that the same current developed the magnetic property in plates of iron or steel which did not previously possess it, and that to communicate magnetism to needles deprived of it, it is necessary to place them in a direction perpendicular to the forming wire, or if a strong degree of magnetic influence is required, it is necessary to introduce them into a helix, and make the current pass across the wire. Savary has observed, that the magnetic influence is produced inversely as the distance of the needle from the wire, and that a given discharge produces always magnetic power, so much the more intense as the length of the wire is greater in relation to its diameter; and that equal fragments of the same needle, in the interior of a helix, were always equally magnetized, Arago having previously shewn, that similar needles are equally magnetized. He considers that all the phenomena which he has observed, may be deduced from the hypothesis, which ascribes the dependence not only of the intensity, but the magnetic influence to laws, according to which, the minute motions are extinguished in the wire, in the medium which surrounds it, and in the substance which receives and preserves the magnetic power. Moll has shewn that the force of the communication of the magnetic power, depends on the rapidity of the current. Lipkins and Quetelet have proved that very powerful magnetic effects may be produced with voltaic elements on a confined surface, if the chemical action is energetic, and that on varying the dimensions of the voltaic elements and the portions of iron, the energy of the effects depends less on the size of the first than on that of the second.

In reference to the power of retention of magnetism on soft iron, Mr. Watkins found that in applying a current across a helix to a piece of iron, a weight of 120 pounds was sustained, but on interrupting the current, 56 pounds only could be supported. He has concluded that the power of suspension of electric magnets depends on a complex *induction*, and that all magnetic phenomena, belonging to this class of effects, derived their origin from this induction.

3. The last chapter in the present volume is devoted to a detail of experiments, in relation to the production of electrical currents, by the action of other currents, a branch of science which has been entirely formed by Dr. Faraday, to which he has given the name, *electro voltaic induction*. The experiment which laid the foundation of these important observations was, that of employing two cylinders of wood, rolling over them, in a spiral form, 12 spirals formed each of 203 feet of copper wire, $\frac{1}{20}$th of an inch in diameter, and covered with silk, and causing one to communicate with the multiplier and the other with a pile of 100 pairs of double copper plates, of 4 inches square, and well charged. At the moment of contact the needle underwent a deviation, then after some oscillations it returned to its position of equilibrium, and was deverted again when the action of the pile was interrupted, but in a contrary way; the force of the inducing current being, however, greater at the moment of contact than when it is interrupted.

But not only are electrical currents induced by currents of electricity, but likewise, electricity is induced by the agency of magnets. This is proved in the case of common magnets, by attaching to the multiplier all the elementary spirals, introducing into its axis a cylinder of soft iron, and then adjusting two magnetized bars, each 24 inches in length, so that on one side, their opposite poles being brought in contact, the two others may touch equally with the two ends of the iron cylinder, in order to transform it for the time into a magnet. At the moment of contact the needle deviates, then assumes its equilibrium, and deviates in another manner when the bars are withdrawn.

Dr. Faraday has applied himself to the investigation of the new electrical state of the substance during induction. He has named this state *electro-tonic*, and considers it as a state of tension equivalent to an electric current, at least equal to the current which is produced when an induction takes place or when it is suppressed. He conceives that when electric currents pass across bodies, the latter become electro-tonic, and give rise to electro-chemical decompositions, the current acting upon a portion of the electricity of the neighbouring body in such a way as to drive off a portion and attract the remainder, as happens in the disengagement of electricity by influence. In reference to the application of the magnetic induction to the explanation of the magnetic phenomena observed by M. Arago, it has been found by Faraday that the electric current which is excited in a metal rotating near a magnet, depends entirely as to its direction on the relation of the position of the metal to the resultant of magnetic action, or with the magnetic curves.

M. M. Nobili and Antinori have suggested a method for discovering the distribution of currents, produced by the influence of magnets of rotating disks. This is by applying the two extremities of the wire of a multiplier, terminated by two thick conical points upon the rotating disk. They have likewise exhibited the analogy of Arago and Faraday's researches.

Faraday has, however, obtained the same results from terrestrial magnetism as from magnets. He made a helix communicate with a multiplier and a cylinder of soft iron which possessed no magnetic power. This cylinder was placed in the helix, which had been directed previously according to the magnetic inclination. The iron becoming magnetic, induction was exhibited as if a magnet had been actually employed. And from his experiments it appears impossible that a metallic sphere can rotate without producing electrical currents in its interior, in a plane perpendicular to the plane of revolution, provided that the axis of rotation does not coincide with the direction of the magnetic inclination. He suggests that in the action of steam engines their metallic mechanism may produce accidental electro-magnetic combinations, which may occasion effects hitherto unobserved. He thinks likewise that admitting the earth to produce currents in her own mass during its rotation, by the electro-magnetic induction, these currents at the surface will be directed into the parts which approach the plane of the equator in a contrary way from those which would take place towards the poles. Hence, if we could examine the subject minutely, we might find negative electricity at the equator, and positive electricity at the two poles.

He has advanced, but with diffidence, an opinion that the aurora borealis may be derived from a discharge of electricity driven towards the poles of the earth, from whence it might be forced, by natural and particular means, to return to the equatorial regions above the surface of the earth. He has observed that the current excited in a copper wire is more powerful than that which is produced by the same magnet in an iron wire; and the metals whose properties he has examined in reference to this may be arranged in the following order: copper, zinc, iron, tin, and lead, which corresponds nearly with their electric conducting power, and with what Babbage, Herschel, and Harris have found in their experiments on magnetic rotation. Faraday arranges the metals in three classes, in reference to their connexion with the magnet; 1, those which are affected when at rest, as iron, nickel, cobalt; 2, conductors of electricity influenced during rotation; 3, those which are perfectly indifferent to the magnet, whether they are at rest or in motion.

It remains now to enquire into the nature of the currents of induction. A striking difference exists between the currents produced by magnetic influence in the helices and the hydro-electric currents, and a remarkable difference between these currents and those derived from an origin connected with heat. This difference has been generally ascribed to the greater tension of the hydro-electric piles than in the thermo-electric piles.

According to the result of an ingenious experiment of M. Peltier, currents of induction are formed by the union of several equal currents, for he obtained by the action of five helices, superimposed on each other, a deviation four times greater than was obtained by a multiplier with one turn; it was double with that of ten turns, and produced no effect upon one formed with a wire of 2000.

In uniting all the helices, so as to produce a single circuit, no effect was produced on the multiplier with a single turn, nor on one with ten, if the diameter of the wire was small; but the action was distinct when the wire possessed a certain thickness. The effect of the multiplier of 2000 turns was tribled. Similar phenomena occur in thermo-electricity.

To explain these facts, and others which have been observed in reference to the interesting subject of induction, it has been conceived that every electric current consists of the combination of two currents, one positive and the other negative.

Article IX.

SCIENTIFIC INTELLIGENCE.

I.—*New Expeditions of Discovery.*

London University, Evening Meeting, 14th January.

Captain Maconochie opened the chair, to which he has recently been appointed in this University, by delivering a lecture on the expeditions of discovery, which are now in progress in South Africa and in British Guayana. The subject is one of great interest, and attracted much attention. The lecturer began by mentioning some facts with regard to the Royal Geographical Society, under whose auspices the travellers have started. This society he observed, was established in 1830, and notwithstanding the political state of distraction which existed in the country at that period, was able in the course of a few weeks to collect no less a sum than £7000, for the purposes of patronising geographical research. It has already done a great deal. No less than 4 volumes of transactions have been published by it, which are full of important details. Through it the account of Lander's successful descent of the Quorra, and of his discovery of the melancholy end of poor Park, was first communicated to the public. The only acknowledged report of Ross' recent perilous voyage was given by this society, and the same observation applies to the enterprising expedition of Lieut. Burnes and Dr. Gerrard across the wilds of Asia. The lecturer read a passage from an address of Lieut. Burnes' description of his feelings at the intelligence, which he received during his perilous journey, of the establishment of this society. He was then with his companion at Bokhara, where a packet of newspapers overtook him conveying the information. New vigour was immediately instilled into their adventurous spirits; as they were now aware that there were some at home who sympathized with them, and who, if they should perish on their route, would nobly rescue their names from oblivion.

To confer additional importance on the influence of this society, his Majesty has been graciously pleased to give his countenance to its labours, and has generously granted an annual premium of 50 guineas to be bestowed on contributors to geographical discovery. Premiums have been already conferred on Lander, Ross, and Burnes.

The society have it now in contemplation to patronise adventurers in the discovery of the unknown regions of Africa and South America. In the former country, with the exception of a few Portuguese settlements on the east coast, visited by Captain Owen, the Cape Colony and the course of the Congo for about 280 miles, the whole of Africa, south of the Line is totally unknown to us. M. Douville it is true, has lately published 3 volumes, and a quarto book of drawings accompanied by a map, descriptive of a journey into the interior, from Benguela on the west coast, where he lays down lakes, rivers, and towns in abundance, as far as about 20° E. L., and 3° or 4° S. L., but it is generally believed, that the whole is an imposition. Captain Maconochie is, however, more charitable, and conceives that the descriptions may be founded on fact, as Douville, who was in London is an intelligent man, and appears to have visited the country, in connexion with the slave trade. On the east coast there seem to be two favourable modes of ingress into the interior of this *terra incognita*. One of these is by a river a little to the south of the equator, termed in our maps Rio Grande, which is doubtless of great size, and if followed, would lead the traveller far into the interior.

The other inviting line of route, is by a river which pours itself into the ocean a little to the north of Delagoa Bay, which is conjectured to be the continuation of the large stream, observed by Campbell in his visit to Kurrachane, a town situated in the interior of the country. It is from this point that the new expedition is to start. What adds to our interest, in reference to this portion of Africa, is the fact of the native tribes in the interior, being well versed in some of the most useful arts of life. The missionary Campbell, was the first who penetrated to Kurrachane, near the 24° of latitude, but his route was speedily followed by some of the Cape traders, who notwithstanding the great land carriage of 1200 or 1400 miles, traded with one nation alone to the amount of £1600. At Kurrachane, we are told, iron is smelted and manufactured into knives, and agricultural implements, of such superior quality as to be nearly equal to steel. Cast iron pipes were seen by Captain Owen on the coast, which were said to be brought from the interior. Agriculture appears also to have made greater progress than to the southward, for at Leetakoo, Campbell observed no stone-walls surrounding the corn fields, while at Mashow and to the northward, these fences were general, and in appearance would have been creditable even to Britain itself.

The author of the treatise on maritime discovery, in Lardner's Cyclopædia, having placed these facts in a strong point of view, before the Geographical Society, suggested the propriety of sending an expedition from Delagoa Bay to Kurrachane. The society immediately entered keenly into this project, which was steadily pursued for 18 months, when pecuniary means were procured for carrying it into execution. Captain James Alexander volunteered to take charge of it; and sailed in September last. News have been received of his arrival at the Gambia, where he touched in his way, and by the present time, it is expected he may have reached the Cape. His instructions are to land on the north of the river at Delagoa bay, and not to endeavour to navigate it, but to cross it, and follow the line of the greatest population, to enquire into the manners and customs, the state of the people in reference to the arts, and to ascertain, what would be the probable consequences of instituting a trade with them, as the existence of the river leading into the interior promises great facilities, should the chances of a successful commercial intercourse be deemed probable. Should he succeed in reaching Kurrachane, he has then performed all that the society have in view, but should his health enable him to penetrate farther, he may endeavour to reach some of the Portuguese settlements, and will then have contributed greatly to our knowledge of this portion of Africa.

With regard to the geography of the country to the northward of Delagoa Bay, Captain Maconochie stated, that from the information which he had collected from an envoy, whom the Imaum of Muscat, has sent to this country for commercial purposes, it appears that there is a large lake or inland sea, termed *Marrabee*, in the interior, which extends as far north as the latitude of Mombaza, and is so broad, that a row boat requires ten days to cross it. This Arab had been on its banks, whither he had gone in company with caravans trading between the coast and that neighbourhood. The natives by peculiar ceremonies are in the habit of receiving strangers into friendship, and when they have once done so, they continue to afford them protection. The Muscat-man has undergone those ceremonies, and has volunteered to accompany any English traveller, and ensures perfect safety, as far as regards the natives. His account of the interior agrees with that of Captain Boutchier who was wrecked on this coast. He further states, that a traveller might accompany the natives in their pilgrimage to Mecca, by Suakem, and would have protection extended to them.

The new expedition into Guyana has for its object the examination of the tract of high land which forms the southern boundary of French Guyana, Surinam and part of Columbia, and divides into two portions the great Oronoco Island, as it may be termed, for the Oronoco has been proved by the travels of Humboldt to communicate by means of the Cassaquairo, with the Rio Negro, which terminates in the Amazon. Humboldt penetrated as far as Esmeraldas, but from this point to the Ocean, as far as regards our knowledge, it may be said all is barren. Mr. Waterton, it is true, reached the frontiers of Brazil, but his attention was almost entirely devoted to the study of zoology, so that he has given little information in reference to the physical features of the country. This tract is interesting, as having been the El Dorado of Sir Walter Raleigh, who mistook mica for gold ore, and as containing his great inland sea and city on its banks, which continue still to have a place in maps, although they appear to have no existence in reality beyond the occurrence of slight inundations. Some French travellers in French Guyana, have recently observed tumuli resembling those of North America, which adds an interest to the investigation of the habits and manners of the Indians.

The idea of sending this expedition has been entertained for some time, but it was only lately that funds could be obtained. The Geographical Society, however, offered to provide £500, which was met by an addition of £1000 by the British Government. The individual intrusted with this expedition is now in the West Indies, preparing at the proper season to proceed up the Essequibo river, in prosecution of his journey.

Note by the Editor.—In listening to Captain Maconochie's lecture, (in my report of which, as far as my recollection goes, I have included every point of importance.) I was rather surprised that he should have omitted to mention the expedition, which several months ago, under the direction of Dr. Smith, proceeded into the interior of South Africa, as from the liberal manner in which preparations have been made for it, and the well known qualifications of the conductor, who is an excellent naturalist, there is some reason for concluding, that the projected expedition of the Geographical Society will be anticipated. Would it not have been more judicious, if the Society had contributed their assistance to an expedition so well supplied with the means of investigating both the physical and moral state of the country? As the present expedition starts from Delagoa Bay, it can have no conveniences for carrying instruments for observation, or geological or botanical specimens, while Dr. Smith, being supplied with commodious Cape waggons, has ample means of returning with splendid collections of natural history specimens, and it is certain, that the enlightened members of the Geographical Society would be the last individuals, who would not say that the objects of science should occupy a most prominent place in expeditions of discovery.

With regard to the expedition suggested by Captain Maconochie to Lake Marrabee, there seems to be no object in view except that of geographical discovery, which although very laudable should always be combined with something higher. I conceive that by far the most desirable route for an expedition of discovery, would be the ascent of the Bahr al Abiad or true Nile, which would lead into the very centre of Africa, now known to be the finest and most fertile portion of that vast continent. If the source of this river were attained, a most interesting tract of country would be investigated, the nature of the Mountains of the Moon, as they have been poetically designated, which in all probability give origin to the Nile and Congo, with numerous other rivers, would be ascertained, and the traveller might then endeavour to make his way to Marrabee, or by the Congo, according as circumstances determined him. The origin of one of the largest rivers in the world, for an account of which we still depend upon the vague reports communicated to Herodotus, (from whose statements it appears, that above 300 miles of the course of this river have never been visited by any modern traveller,) of the savage expeditions would be determined. In selecting individuals to undertake these expeditions, however, it would be proper to employ such as have acquired considerable knowledge of Science, and if intelligence that such journeys were in contemplation, were more generally disseminated, I am convinced that persons could be procured, possessing the necessary requisites. Two persons with a servant could accomplish a great deal, viz. a Medical man having a knowledge of Geology and Natural History, and a Navy Officer who would require to be a draughtsman and a good practical astronomer. Every one who engages in such enterprises must reconcile his mind to the worst that can happen, and must not anticipate kind treatment from natives, for although one tribe may afford protection, its very sympathies may be excited by its inferiority to more savage neighbours.

II.—*Improvement in the Arts.*

Printing in Colours.—It has long been a subject of regret that notwithstanding the high state of perfection which the arts of printing and engraving have reached, that hitherto attempts at printing in colours have been attended with complete failures. Mr. G. Baxter, Wood-engraver, King's Square, Goswell Road, has however, succeeded in printing in colours from wood, so successfully, that we consider it proper to call the attention, especially of naturalists, to the works of this meritorious young artist, who, being master both of engraving and printing, will be enabled, if properly encouraged, to make great improvements in this interesting branch of art, which he may be said to have originated. We have before us a delineation of Howard's Modifications of Clouds, in which the superiority of the new style over the common method of colouring is most strikingly exhibited.

III.—*On the native country of Maize (Zea mays.)*

Roulin, Humboldt, and Bonpland, have noticed this plant in its native state, in America, and have hence concluded that it was originally derived from that country. Michaud, Daru, Gregory, and Bonafous state, that it was known in Asia Minor before the discovery of America. Crawford, in his History of the Indian Archipelago, tells us that maize was cultivated by the inhabitants of these islands, under the name of *djagoung*, before the discovery of America. In the Natural History of China, composed by Li-Chi Tchin, towards the middle of the sixteenth century, an exact figure is given of maize, under the title of *la-chou-cha*; and Rifaud, in his " Voyage en Egypte, &c., from 1805 to 1827," discovered this grain in a subterraneous excavation in a state of remarkably good preservation. M. Virey, however, refutes these statements, *(Journal de Pharmacie*, xx. 571,) by shewing that these authors have mistaken the *holcus sorghum* for maize, and that the maize of Rifaud is the *holcus bicolor*, a native of Egypt according to Delile. Where maize occurs in the east their is no proof of its having been carried there previously to the discovery of America.

Maize, (Zea mays) therefore sprung from America; *millet,* or *couz couz,* from Africa; *rice, (oryza sativa,)* from Asia; and wheat, barley, and oats, from Europe.

IV.—*Hydrate of Iron, an antidote for arsenious acid.*[*]

Dr. Bunsen of Gottingen has proposed the hydrate of iron as an antidote in cases of poisoning by arsenious acid, for he finds that a solution of the acid is completely precipitated by the hydrous oxide. He has observed likewise that if the latter body is exposed to a gentle heat with arsenious acid in very fine powder, an arsenite of iron is formed. He has ascertained by experiments on dogs that from two to four drachms of the oxide, mixed with sixteen drops of ammonia, are sufficient to convert eight or sixteen grains of *arsenious acid* into an insoluble arseniate.

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[*] Journal de Pharm, xx.

V.—*New Pharmaceutical Preparations,*

Employment of white oxide of lead in tic douloureux.—This oxide has been employed in France with great success in the painful affection of the face, known by the name of tic douloureux. A layer of the following mixture

Ceruss, 1 ounce. White oxide of lead 2 or 4 gr.

is applied to the part affected, to the depth of half a line. The intensity of the pain speedily subsides, and gradually dissappears.—*Journal de Pharm.* xx. 603.

Collyrium of Nitrate of Silver of Dr. Munaret.—Take of saturated aqueous solution of nitrate of silver iv. gr.

Distilled water, 1 ounce. Laudanum, iii. gtt.

This is very useful in chronic inflammation of the conjunctiva, and even in the acute inflammation of the globe of the eye. The action may be assisted by leaching and aperient medicines.

The *Boletus Larycis,* or white mushroom, is recommended by M. Andral, in colloquative sweats. He prescribes it to the extent of 48 to 60 gr. made into pills of 8 gr. each, without observing any effect upon digestion, although it was long supposed to be a drastic purgative.

M. Pouché has found the *Cyanuret of gold,* useful in siphilis and scrophula. M. Figuier recommends that in preparing this compound the chloride of gold should be neutral, that the cyanuret of potash should not be alkaline, and should be free from formate and carbonate of potash. What remains after the calcination of ferro-prussiate of potash in close vessels answers very well, when dissolved and carefully precipitated with the salt of gold, avoiding any excess of the potash salt. M. Pouché rubs it on the tongue mixed with an inert powder, such as iris of Florence washed with alcohol in the proportion of 1 gr. cyanuret of gold to 3 gr. powder of iris. In the form of pills it may be given in the following: Cyanuret of gold 1 gr. Extract of daphne mazereum 3 gr. Powder of Mallows *q.s.* for 5 pills. For children it may be made up with chocolate paste. We should always begin with $\frac{1}{15}$th of a grain.

VI.—*Register of the fall of Rain during* 1834, *kept at the Macfarlane Observatory, Glasgow University.*

	Inches.
January	3·954
February	1·368
March	1·759
April	0·134
May	0·762
June	2·078
July	1·183
August	2·523
September	2·578
October	1·403
November	3·007
December	1·112
	21·861

RECORDS

OF

GENERAL SCIENCE.

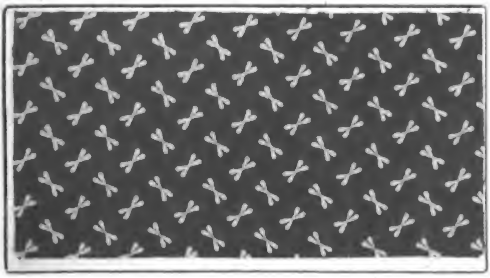
MARCH, 1835.

Article I.

On Calico-Printing. By Thomas Thomson, M.D., F.R.S., L. and E., &c., Regius Professor of Chemistry in the University of Glasgow.

(*continued from* p. 19.)

13. *White discharge on Madder-Red.*

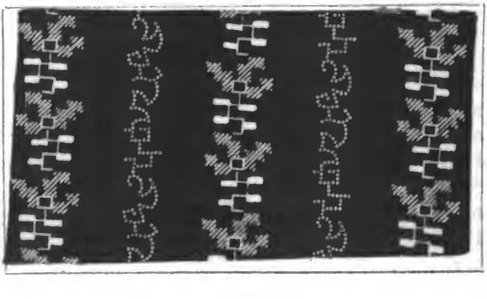


When the aluminous mordant already described is printed on the cloth its basis (*alumina*) becomes fixed, and ready to combine with whatever colouring matter may be subjected to its action. Another mode of applying the same mordant, and producing patterns with it, is to impregnate the whole cloth with it, and afterwards to print the figure with a substance which has the power of rendering alumina soluble in water. The cleansing processes to which all cloths impregnated with mordants are subjected before dyeing, remove that portion of the alumina which has been rendered soluble, and leave portions of the cloth in the shape of flowers, crosses, &c., without any material capable of fixing the dye-stuff. When the cloth is dyed in the way already described these portions remain white, or at least become white after the requisite washing.

The substance which has been found to answer best for the removal of alumina and peroxide of iron is *citric acid.* Some of the advantages of such an acid are obvious. It does not corrode the cloth, though subjected to a considerable degree of heat. It is a fixed acid, with little tendency to swell or travel to other portions of the mordant than those with which it is intended to be combined; and it has the advantage over other vegetable acids of dissolving away very completely all the alumina or oxide of iron, so that no portion of these mordants is retained by the cloth. When we consider the ease with which this acid is abstracted by water, from the insoluble citrates, we would, a priore, infer that it is very little adapted for this purpose of the calico-printer, which, in fact, it is found to answer better than any other. But the probability is that water has no such tendency to abstract it from the soluble citrates, as *citrate of alumina, and citrated peroxide of iron.*

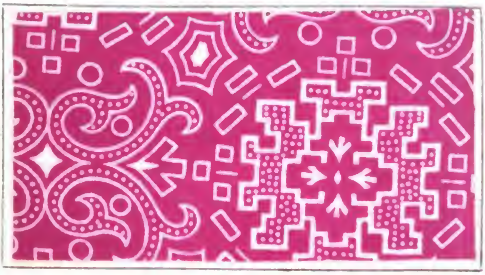
The citric acid is often printed before as well as after the application of the mordant. In the latter case it is generally assisted by *bisulphate of potash*, or even sulphuric acid, by which the more expensive acid is economized.

14. *Madder and Logwood.*



The cloth is impregnated with the aluminous mordant which is discharged on the white portions by the method just described. It is then dyed with madder in the usual way, only a quantity of logwood is mixed with the madder. This logwood changes the madder-red to brown, and produces the colour observable in the accompanying piece of calico.

15. *Cochineal Pink.*

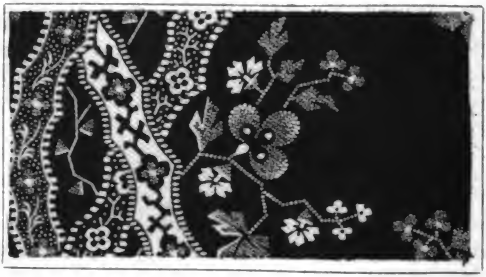


The cloth in this case also is impregnated with the same aluminous mordant, and the white portions are discharged by means of citric acid, in the way described in a former paragraph. It is then dyed in cochineal, which communicates the beautiful pink observable in this specimen of cloth.

For this beautiful dye we are indebted to America. Cochineal is the name given to a small insect which inhabits the *cactus coccinilifera*, and three or four other species of cactus, on which it remains immoveable, deriving its nourishment from the juices of the plant. It is a native of Mexico, and had been employed by the natives as a red dye. When the Spaniards entered that country in 1518, it drew their attention, and in 1523 Cortes received orders from the Court of Spain to procure as great a quantity of it as possible. The earlier Spanish writers describe cochineal as an insect; but it came afterwards to be considered as the seed of a plant; and this erroneous notion was not fully cleared away till about the middle of the eighteenth century.

The red principle in cochineal may be extracted by means of alcohol. It has a fine purple colour, and may be obtained in small crystals. It melts at 122°, and when heated, is decomposed without yielding any ammonia, from which we may conclude that it contains no *azote*. It dissolves readily in water and alcohol, but not in ether. Acid gives it a yellow tinge. Hence the reason why bitartrate of potash must be added when we wish to dye scarlet with cochineal alone. If we agitate newly precipitated alumina in an aqueous solution of cochineal, the colouring matter combines with the alumina, and gives it a fine red colour. The paint called *carmine* is alumina impregnated with *cochinealin*.*

16. *Black Ground and White.*



The method of fixing the colouring matter in this case is precisely similar to the two last examples: the sole difference lies in the dye-stuff used. The calico is in the first place impregnated with the aluminous mordant. The mordant is afterwards discharged by means of citric acid from those parts of the cloth that are to remain white. It is then dyed to saturation in logwood.

Logwood is the wood of the *hematoxylon campeschianum*, a tree which grows to a considerable size in Jamaica, and on the eastern shore of the Bay of Campeachy. It owes its dyeing powers to a colouring matter which it contains, to which the name of *hematin* has been given. If we digest the raspings of logwood in warm water, evaporate the infusion to dryness, dissolve the residue in alcohol, and distill off the alcohol to a syrup, and set the syrup aside, crystals of hematin are deposited. They are needles arranged in sphericles, and having a fine scarlet colour. Hematin is but little soluble in water; but it dissolves in alcohol and ether. It combines both with acids and with bases. It has a strong affinity for alumina, and may be united at the same time with different metallic oxides.

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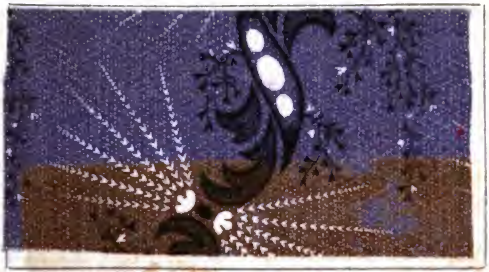
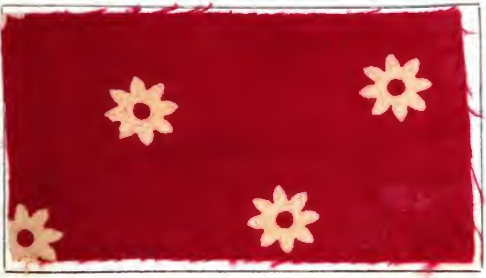
* This is the name given by chemists to the colouring matter of cochineal.

17.



In this calico two engravings are employed. The deep colour and the white objects are printed at once, by two copper rollers, in the same machine: the white being the lemon juice already described, thickened with gum-senegal. After this another roller applies the ground work over the whole piece with a solution of iron. The iron becomes fixed on the cloth every where except where the acid has been applied, which remains white.

18. *Turkey-Red and White Bandanas.*



The word *bandana* has been appropriated to cotton printed pocket handkerchiefs. By far the most beautiful and the best known of these are the *Turkey-red* dyed handkerchiefs, with white spots, stars, or crosses, such as the specimen now presented to the reader.

What is called by the name of the *Turkey-red dye* has long been known in the Levant, and in different parts of Turkey. From that country it made its way to France, and about fifty years ago it was begun in Glasgow, by a Mr. Papillon, who established a Turkey-red dye-work along with Mr. M'Intosh. He made an agreement with the commissioners and trustees for manufactures in Scotland, that the process was to be by them published for the benefit of the public at the end of a certain term of years. Accordingly, in the year 1803, the trustees laid a minute account of the different steps before the public. The process has been followed in Glasgow ever since, and many improvements have been introduced. The method of discharging the colour, as exhibited in the specimen, was first practised on an extensive scale by Henry Monteath and Company, at Rutherglen Bridge. It is probable that the process was discovered by more than one individual about the same time. I know of at least three claimants; but not having the means of determining the priority of any of them, I think it better to avoid uncertain details.

The method of fixing the Turkey-red dye on cloth is complicated and tedious. I shall here give a sketch of the different steps, and explain them so far as they are understood.

(1.) The cloth is steeped in a weak alkaline ley, to remove the weaver's dressing. This is technically called the *rot-steep.* Four or five pounds of caustic potash are generally employed for every 100 lbs. of cloth. The temperature of the solution is from 100° to 120°; the cloth is kept in the steep for 24 hours and then well washed.

(2.) From 7 to 10 lbs. of carbonate of soda are dissolved in a sufficient quantity of water to keep the cloth (always supposed to weigh 100 lbs.) wet. In this solution the cloth is boiled for some time.

(3.) It is upon the third process that the beauty of the colour depends more than upon any other. Without it the dye cannot be produced upon new cloth; but when old cotton cloth that has been frequently washed (a cotton shirt for example) is to be dyed, this process may be omitted altogether.

A liquor is composed of the following ingredients:—

1 gallon of gallipoli oil

1¼ gallon of soft sheep-dung

4 gallons of a solution of carbonate of soda, of the specific gravity 1·06

1 gallon of solution of pearl ash, of the spec. grav. 1·04.

mixed with a sufficient quantity of cold water to make up 22 gallons. The specific gravity of this liquor should be from 1·020 to 1·025.

This liquor has a milk white appearance, and is, in fact, a kind of imperfect soap. It is put into a large wooden, open, cylindrical vessel called the *liquor-tub;* and is kept continually in motion (to prevent subsidence) by wooden levers, driven round in it by machinery. This liquor is conveyed by tin pipes to a kind of trough, in what is called the *padding-machine*, where the cloth is thoroughly soaked in it. The longer the cloth is allowed to remain impregnated with this liquor the better does it take the dye. Fourteen days is the least period that this impregnation is allowed to remain.

The sheep dung gives the cloth a green colour, and is found materially to assist the bleaching process to which it is afterwards subjected. It is found to increase the rapidity of the bleaching, especially when the cloth is exposed on the grass between the different operations.

(4.) In favourable weather the cloth impregnated with the imperfect soap of No. 3, is spread upon the grass to dry. But in rainy weather it is dried in the stove.

(5.) The cloth thus dried is a second time impregnated with the oleaginous liquid of No. 3. It is then dried again.

The impregnation and drying processes are repeated a third time.

(6.) The cloth is steeped in a weak solution of pearlash, of the specific gravity 1·0075 to 1·01, heated to the temperature of 120°. From this liquor it is wrung out and again dried.

(7.) A mixture is made of the following substances:—

1 gallon gallipoli oil

3 gallons soda ley, of sp. gr. 1·06

1 gallon caustic potash ley, of sp. gr. 1·04,

diluted with as much water as will make up the whole to 22 gallons. In this liquid it is soaked as it was with that of No. 3.

The cloth thus impregnated is in fine weather dried on the grass, in rainy weather in the stove.

(8.) The process No. 7 is repeated thrice, and after each soaking the cloth is exposed for some hours on the grass, and finally dried in the stove.

(9.) The cloth is steeped in a mixed ley of pearlash and soda, of the specific gravity 1·01 to 1·0125, heated to the temperature of 120°. It is allowed to drain for some hours and then well washed. It is then dried in the stove. The object of this process is to remove any superfluous oil which might adhere to the cloth. Should any such oil be present, the succeeding process, *the galling*, could not be accomplished.

(10.) For the galling, 18 lbs. of alleppo galls are to be boiled for four or five hours in 25 gallons of water, till the bulk is reduced to about 20 gallons. This liquid, after straining, is strong enough to impregnate 100 lbs. of cloth, with the requisite quantity of nut galls. Of late years *sumach* from Sicily has been substituted for nut galls; 33 lbs. of sumach being reckoned equivalent to 18 lbs. of nut galls. Sometimes a mixture of 9 lbs. of nut galls and 16½ lbs. of sumach is employed.

In this liquor, heated to 80° or 100°, the cloth is fully soaked. The sumach gives the cloth a yellow colour, which serves to improve the madder-red, by rendering it more lively.

(11.) The next process is to fix the alumina on the cloth. This step (as has already been observed) is essential, because, without it the madder dye would not remain fixed.

In this country alum is used by the manufacturers; but in many parts of the Continent acetate of alumina is employed. To form the alum liquor of the Turkey-red dyers, to a solution of alum of the specific gravity 1·04, as much pearlash, soda, or chalk is added, as is sufficient to precipitate the alumina contained in the alum. Through this muddy liquor, (which should have a temperature from 100° to 120°,) the cloth is passed and steeped for twelve hours. The alumina is imbibed by the cloth, and unites with its fibres.

(12.) The cloth thus united with alumina is stove-dried, and then washed out of the alum liquor.

(13.) These essential preliminary steps having been taken, the cloth is ready to receive the red dye.

From 1 to 3 lbs. of madder, reduced to the state of powder, for every pound of cloth is employed; the quantity depending upon the shade of colour wanted. The cloth is entered into the boiler while the water is cold. It is made to boil in an hour, and the boiling is continued for two hours. During the whole of this time the cloth is passed through the dyeing liquor by means of the winch.

For every 25 lbs. of cloth dyed, one gallon of bullock's blood is added. This is the quantity of cloth dyed at once in a boiler. The addition of the blood is indispensable for obtaining a fine red colour. Many attempts have been made to leave it out, but they have been unsuccessful. I suspect that the colouring matter of blood is fixed upon the cloth. Its fine scarlet tint will doubtless improve the colour of madder-red.

(14.) Madder contains two colouring matters, a *brown* and a *red*. Both are fixed on the cloth by the dyeing process, giving the cloth a brownish red, and rather disagreeable colour. The brown colour is not nearly so fixed as the red. The object of the next process, called the *clearing process*, is to get rid of the brown colouring matter. The cloth is boiled for twelve or fourteen hours in a mixture of 5 lbs. soda, 8 lbs. soap, and from 16 to 18 gallons of the residual liquid of No. 9, with a sufficient quantity of water. By this boiling the brown colouring matter is mostly removed, and the cloth begins to assume the fine tint which characterizes Turkey-red dyed cloth. It is still further improved by the next process.

(15.) Five or six pounds of soap, and from sixteen to eighteen ounces of protochloride of tin, in crystals, are dissolved in water in a globular boiler into which the cloth is put. The boiler is then covered with a lid, which fits close, and the boiling is conducted under the pressure of two atmospheres, or at the temperature of $250\frac{1}{2}°$. The boiler is furnished with a safety valve and a small conical pipe, the extremity of which has an opening of about $\frac{3}{16}$ths of an inch in diameter, from which there issues a constant stream of steam during the operation. The salt of tin is found materially to improve the colour. Probably the oxide of tin combines with the oleaginous acid of the soap (fixed in the cloth.) This insoluble soap doubtless unites with the red colouring matter of the madder, and alters the shade.

(16.) After all these processes, the cloth is spread out on the grass, and exposed to the sun for a few days, which finishes the clearing.

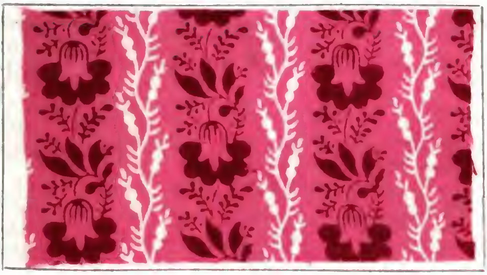
Such is a very short, but accurate, sketch of the Turkey-red dyeing, as practised in the principal works in Glasgow. Many attempts have been made to shorten the processes, but hitherto without success. The impregnation with oil, or rather soap, is essential. If one, two, or three immersions be omitted, the red is inferior in proportion to the omissions. Doubtless this soap combines with and remains attached to the cloth. And the same remark applies to common soap.

Cloth bleached with chloride of lime does not produce a good red. Doubtless the fibres of the cotton wool combine with lime or rather with sulphate of lime, which, by decomposing the oleaginous soap, prevents it from combining with cloth. But cloth bleached by the old process, namely, boiling in ley or soap, and exposure to the action of the sun answers perfectly. The colours would be as good without the galls as with them. But there would be considerable difficulty in sufficiently impregnating the cloth with the alum liquor, without its being previously passed through the alum decoction, especially if the cloth be in the least degree greasy.

The whole cloth, of which a specimen is shown at No. 18, is dyed Turkey-red. The white stars with eight rays constitute an after process, and are formed by *discharging* the dye by means of water impregnated with *chlorine.* Fifteen pieces of cloth, dyed Turkey-red, are laid flat upon each other on a plate of lead of the size of the pocket handkerchief. Another plate of lead is laid over them, and the two plates are pressed violently together, either by means of screws, or in the more perfect establishments, by the Bramah press, exerting a pressure of about 200 tons. Through the upper plate are cut holes corresponding exactly with the star, cross, &c., to be discharged on the cloth. A solution of bleaching powder, mixed with an acid to set the chlorine at liberty, is made to flow over the upper plate, and forced by ingenious contrivances to pass through the cavities cut in the plate. It penetrates through all the fifteen pieces of cloth, discharging the colour, while the violent pressure effectually prevents it from spreading to those parts of the cloth which are to retain the colour.

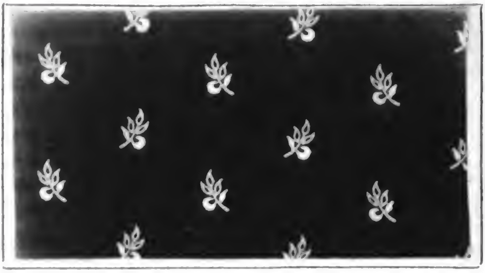
When this process was first put in practice, the edges of the holes in the lead were left sharp, the consequence of this was, that the violent pressure to which they were subjected caused them to cut the cloth, so that the whole spots soon fell out, leaving holes in their place. This was ascribed to the corrosive effect of the chlorine, whereas, it was in reality owing to the bad construction of the leaden plates. Henry Monteath & Co. were the first persons who manufactured these handkerchiefs, or bandanas, as they are called, and they realized by them a very large fortune.

19. *Two Turkey-Reds and White.*



This is an improvement on the original bandanas described in the last paragraph. The two reds are dyed at the same time; difference in the tint is owing to the aluming, a much greater portion of the alumina, being fixed upon those parts of the cloth that are to have the deep red than those that are to receive the light red. The white flowers and sprigs are produced by discharging the dye. The method of doing this was originally contrived in France. Mr. Thomson of Primrose Hill, near Clitheroe, took out a patent for it about eighteen years ago, which having now expired, the process is open to every person. To accomplish it, a solution of tartaric acid thickened with gum-senegal, is printed in the usual way upon those parts of the cloth that are to be white. The cloth is then passed slowly through a solution of chloride of lime. The acid disengages the chlorine from the bleaching liquor, and the free chlorine discharges the colour. The cloth is immediately passed through pure water to prevent the discharge from spreading.

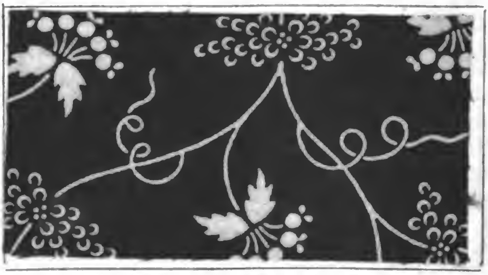
20. *White Discharge upon Bronze.*



The cloth is first soaked in a solution of sulphate or chloride of manganese, and dried. It is then passed through a strong caustic alkali, by which the white hydrated protoxide of manganese is precipitated on the cloth. This, by exposure to the air gradually darkens, being converted into sesquioxide; and this change is further promoted by the action of bichromate of potash.

Protochloride of tin is the substance best adapted for producing white figures upon this ground. By its means chloride of manganese is produced, which is readily removed by water; while peroxide of tin either takes the place of the manganese or may be also rendered soluble by employing a free acid along with the solution of tin.

21. *White upon Blue.*



The blue vat is a solution of deoxidized indigo in lime-water. To form it the indigo is ground to a fine paste with water, and then mixed with sulphate of iron and an excess of lime. In a few hours the indigo is deoxidized and dissolved. The new products, peroxide of iron and sulphate of lime, are allowed to subside, and a clear yellow coloured solution of indigo remains. When a piece of cloth is dipped in this solution the yellow indigo immediately quits the lime to deposit itself upon the fibres of the cloth. When the cloth is exposed to the air the indigo soon recovers its oxygen and becomes blue.

The indigo solution has a yellow colour, but its surface is always blue; or, if very strong, copper coloured, from the oxidizement of the indigo by the contact of air. Acids throw down from it white indigo; while those metallic oxides that readily part with their oxygen throw down the indigo in a blue state. This is the case with the sesquioxide and binoxide of manganese, the salts of copper and its blue hydrate. And these substances are taken advantage of by the printer to produce various effects upon his calicoes. In the specimen before us oxide of copper has been employed to prevent the indigo in the blue vat from attaching itself to particular parts of the cloth. For this purpose a solution of the sulphate or acetate of copper made into a paste with flour or pipe-clay and gum-senegal, is printed upon the white cloth, and when dry, the whole is immersed in the blue vat. The indigo becomes fixed upon those parts of the cloth where no paste has been applied; but, on the surface of the paste it is arrested by the copper, which, by yielding oxygen, renders the indigo blue and insoluble before it can reach the cotton. A little of the copper remains after washing, which is taken away by means of sulphuric acid.

(To be continued.)

ARTICLE II.

Researches into the Number of Suicides and Murders committed in Russia in 1821–22. By M. C. T. Hermann, [read 1832 and 1833.] (*Petersburgh Memoirs*, ii. 257.)

THE results detailed in this paper were procured from the governors of the different provinces. The population, according to the returns derived from them, of the provinces collectively, was in 1820, 39,030,072; and in 1827, 39,572,633. Since 1812 the increase of the population has been very rapid. For the seven years alluded to, the increase of the industrious population was 75,508 annually. Hermann begins with the western provinces of Moscow, Yaroslav, Vladimir, Riazan, Toula, Kalouga, Kostroma, Orel, Koursk, and Voronega, where the people are chiefly Russians. In 1820 the population of these provinces amounted to 10,593,251. In this population there were in 1821, 520 suicides; and in 1822, where the cases were investigated, 505; total, 1,025; mean = 512½; while the number of non-investigated suicides was in 1821, 132; and 1822, 168; total 300; mean 150. The total of these two classes of suicides amounted therefore in 1821 to 652; and for 1822, 673; total 1,325; mean 662½. The number of homicides in 1821 was 223, and in 1822, 200; total 423; mean 211½. The proportion to the population therefore is,

1 investigated suicide to . .	20,669	inhabitants.
1 non-investigated suicide to	70,621	,,
1 suicide of both classes to	15,989	,,
1 homicide	50,086	,,

Hence, the suicides were above three times more numerous than the homicides, and the latter to the former in the proportion 1 to $3\frac{1}{7}$.

The following table exhibits a relative statement of the investigated suicides in the different governments for 1821-22:

		Investigated.	Non-investigated.
Moscow . . .	39½ town 72½ country	112	22 town 9 country.
Yaroslav		68½	16
Vladimir		55	13½
Orel		48½	10
Toula		44½	11
Kalouga		40	8
Voronega		38	32
Riazan		37	22½
Kostroma		8	1
		512½	

From this enumeration, compared with former years, it appears that the number of suicides has not increased in Kostroma. In Toula and Kalouga the difference is trifling. But in the most industrious governments, where the passions are more liable to be excited, as Moscow, Saratov, Vladimir, the number is on the increase. The proportion of suicides to the population appears from the following table :—

Town of Moscow: one suicide to		6,250	of both sexes.
Government of		11,678	,,
,,	Vladimir	18,207	,,
,,	Kalouga	20,770	,,
,,	Toula	21,165	,,
,,	Koursk	21,536	,,
,,	Orel	24,362	,,
,,	Riazan	28,697	,,
,,	Voronega	32,710	,,
,,	Kostroma	120,546	,,

As it is not easy to determine when there is no examination into a case, what is the cause of death, the uninvestigated tables may contain some errors. But in the following enumeration the non-investigated suicides are alone referred to:—

	Miles Square.	Inhabitants to the mile square.	Suicides not Investigated.
Voronega	1,363	985	32
Moscow	481	2,488	31
Riazan	731	1,455	22½
Yaroslav	609	1,444	16
Vladimir	874	1,145	13½
Orel	790	1,495	10
Toula	542	1,757	11
Kalouga	541	1,535	8
Koursk	743	1,768	5
Kostroma	1,439	671	1

Kostroma, in all the previous statements, presents always a very extraordinary example of good morality. The non-investigated suicides in that province amount only to one, although it has the greatest extent; much wood in it, and a very active navigation on the Volga. The quality of its soil is very inferior, the agriculturist has much to do in cultivating it, for nature has done little.

Voronega, with an immense extent of surface, possesses but a small population. It forms part of the *Steppes*, and hence the number of non-investigated suicides.

Koursk is of great extent, but has a more concentrated population, and few non-investigated suicides.

Orel, with a greater extent and fewer inhabitants, has double the number of these cases. Riazan possesses a woody and marshy surface.

Vladimir is extensive, with a concentrated population.

Toula, which is of considerable size, has a good population, and is more of a manufacturing than agricultural country. There are few non-investigated cases. Kalouga is an agricultural country, and contains still less. It is a striking proof of the good state of the police in Moscow, that there are only nine cases of doubtful issue in that city.

In comparing the population with the number of doubtful suicides, we find that one occurs in

Vladimir for every	37,088	inhabitants.
Voronega	41,968	,,
Riazan	47,190	,,
Yaroslav	54,995	,,
Toula	85,715	,,
Moscow, Government	94,077	,,
Capital	11,731	,,
Kalouga	103,852	,,
Orel	118,105	,,
Koursk	202,735	,,
Kostroma	914,372	,,

It is remarkable that Koursk, on the S.W. of this plain (of the Oka,) and Kostroma, on the E.N.E., bear the most favourable results.

Kalouga, Toula, Moscow, and Yaroslav, on the N.W., surpass in this respect the governments situated more towards the E. Vladimir, Riazan, and Voronega.

Homicides.—The mean number of these for the two years is 211½, which are divided among the governments as follows:—

Moscow	33½	—(9½ in the town, 24 for the government.)
Orel	28	
Koursk	27	
Toula	27	
Riazan	23½	
Kalouga	19½	
Vladimir	17½	
Yaroslav	17½	
Voronega	10½	
Kostroma	7½	
	211½	

Comparing this table with the former results, we find Kalouga and Kostroma holding the same situation. There are fewer homicides in 1822 in Moscow than in 1820, and the same observation holds good with regard to Orel, Toula, and Vladimir, &c.

With regard to the relation of the homicides and suicides to the order in which the governments follow, for these crimes in 1822, it appears that the capital and government of Moscow has the greatest number of these two kinds, and Kostroma the least. Suicides are more frequent than homicides in Yaroslav and Vladimir, and the latter more numerous in Orel, Toula, Riazan and Kalouga. This is perhaps explained by the greater or less concentration of the population.

The proportion of the homicides to the population is as follows:

Moscow, Capital	1 to 27,125	32,966
Government	35,279	
Toula	34,921	
Orel	42,180	
Kalouga	42,629	
Riazan	45,608	
Koursk	48,655	
Yaroslav	50,281	
Vladimir	57,222	
Voronega	127,903	
Kostroma	128,583	

Here, it is remarkable that Voronega and Kostroma, the most extensive governments, exhibited the most favourable state.

With regard to the proportion of the sexes who have committed crimes, the returns of registers show that in

1821, 428 men and 92 women committed suicide.
1822, 406 ,, 99 ,, ,, ,,
Total, men . . 834 mean for the year 407
Total, women 191 ,, ,, 95½

or one women to 4⅜ men.

Of non-investigated cases in

1820, there were 111 men, 21 women.
1822, ,, 146 ,, 22 ,,
Total, men . . 257; mean 128½
Total, women . 43 ,, 21½

or one woman to six men.

Total Suicides.

1821,	Men 539.	Women 113
1822,	,, 552.	,, 121
	1091	234
	mean 545½	mean 117

or one woman to $4\frac{3}{9}$ men.

The interest of these details increases when we take into consideration the condition of the people among whom these crimes exist.

Peasants.

1821, 387 men, 71 women.	Total, 787 men; mean 393½
1822, 400 ,, 98 ,,	,, 169 women ,, 84½

Mean of the two sexes, 478.

Merchants, Workmen, and Free People.

1821, 77 men, 22 women	Total, 154 men; mean 77
1822, 77 ,, 16 ,,	,, 38 women ,, 19

Mean of the two sexes, 96.

Soldiers.

1821, 57 men, 17 women	Total, 110 men; mean 55
1822, 53 ,, 6 ,,	,, 23 women ,, 11½

Mean of the two sexes, 66½.

Nobility.

1821, 15 men, 3 women	Total, 32 men; mean 16
1822, 17 ,, 1 ,,	,, 4 women ,, 2

Mean of the two sexes, 18.

Clergy.

1821, 3 men — women	Total, 8 men; mean 4
1822, 5 ,, ,,	

To render this statement more interesting, it would be proper to have an enumeration of the population of the various classes. Hermann, however, gives only a rough calculation, which is as follows:—Considering the total 10½ millions, there are of

Peasants	8,000,000
Third state . . .	2,000,000
Clergy	100,000
Nobility	200,000
Military	200,000

According to the different conditions a suicide occurs in the proportion among

Peasants	of 1 to	16,757½	inhabitants.
Tiers etat	,,	20,833⅓	,,
Soldiers	,,	3,009	,,
Nobility	,,	11,111	,,
Clergy	,,	25,000	,,

Among the peasantry there are

At Moscow, 95 suicides in a male population of 424,605
Proportion of suicides 1 to 4,446⅛

Yaroslav 66½		368,839
,,	,, 5,997½	
Vladimir 48½		461,682
,,	,, 9,518⅜	
Voronega 27		274,329
,,	,, 10,170⅙	
Toula 31½		359,259
,,	,, 11,461⅞	
Kalouga 31		358,940
,,	,, 11,578⅔	
Riazan 36		434,640
,,	,, 12,073⅓	
Koursk 26½		339,635
,,	,, 12,816⅖	
Orel 23½		488,929
,,	,, 20,805½	
Kostroma 7½		399,248
,,	,, 53,233½	

Among the *tiers etat* the numbers are :

Koursk 21 suicides in		264,068
	or 1 in 12,574⅔	
Voronega 15		292,725
	,, 19,515	
Orel 15		144,303
	,, 9,620⅕	
Moscow 8½		51,218
	,, 6,025⅗	
Riazan 8		54,605
	,, 6,825⅝	
Vladimir 3		13,075
	,, 4,358⅓	
Yaroslav 2½		15,903
	,, 6,361⅕	
Kalouga 2		20,854
	,, 15,427	
Toula 2		49,528
	,, 24,764	
Kostroma	no example	11,179

Among the clergy, in two years, at Moscow, the proportion is 1½ to 6,853
Yaroslav, 1 to . . 3,664
Riazan, 1 to . . 6,897
Koursk, ½ to . . 7,035

In the other six governments, among 40,307 persons, there are no suicides among this class.

It appears, therefore, that suicides happen most frequently among the peasants of Moscow and Yaroslav, and more rarely among those of Orel and Kostroma. The free agricultural labourers belonging to the third class are very numerous in Koursk, Orel, and Riazan.

The nature of the death is interesting in relation to the manners:

	Men.	Women.	Total.
Deaths from drunkenness .	242	29	271
,, by hanging . . .	136	63	199
,, *brule la cervelle** . .	19	1 in 1821	
,, cutting the throat .	11	1	
,, drowning	6½	1	
,, poisoning	2	1	

The cases from drunkenness occurred in the governments in the following proportions:

	Men.	Women.	Total.
Moscow town . . .	14½	4	} 66½
,, government .	44	4	
Yaroslav	51	5	56
Vladimir	39	4	43
Koursk	24	2	26
Riazan	16	1½	18
Kalouga	16	1½	17½
Toula	12	2	14
Orel	11	3	14
Voronega	8	1½	9½
Kostroma	6½	½	7

The cases of premeditated suicide are most frequent among the peasants and soldiers, and are performed by hanging, and occur most numerously in Moscow, Koursk, and Orel, being rare in Yaroslav and Vladimir, and almost unknown in Kostroma. The species of death by violence among the nobles, and sometimes among the soldiers, is *bruler la cervelle*. At Moscow a magistrate and a student died in this manner.

---

* Literally, burning or searing the brain.

Among women it never happens. Cutting the throat is not common. At Moscow, in 1821, a stranger cut his throat with a razor. There were only eleven cases in eight governments. Poisoning is very rare. At Moscow, in 1822, a soldier was poisoned, and a female servant, by her lover. At Yaroslav, in 1822, a young officer was poisoned; in 1822 a peasant; and in Voronega, in 1821, a soldier suffered the same fate. In six governments, only seven cases of premeditated suicide occurred. In 1822 a student at Moscow threw himself from a window, and in the same year, a merchant of a melancholic temperament killed himself in a similar manner.

The causes which have occasioned the suicides are extremely interesting, as they throw some light upon the analogous situation of persons of the same class; but, in general, they are unknown. A few, however, have been ascertained.

In Moscow a peasant hanged himself in a passion during 1821. In Kalouga, a peasant, overcome with melancholy, strangled himself in 1822. A peasant at Riazan, in 1821, afraid of being inlisted; in 1822 another, afraid of being punished by his master, committed the same crime. Similar acts were perpetrated by peasants in Kostroma, from low spirits, in 1822; by another in Toula in 1821, in consequence of being punished by his master; and a third in 1821, in Orel, afraid of punishment; a fourth for having lost his horse, which a peasant had taken from him for debt.

In a population of $10\frac{1}{2}$ millions one homicide occurs for every $49,645\frac{1}{2}$ inhabitants. Of this number 141 are men, 33 women, and $37\frac{1}{2}$ children: in the proportion of

Men to women . .	$4\frac{3}{11}$	to 1
,, children . .	$3\frac{4}{5}$	,, 1
Women ,, . .	2	,, $1\frac{1}{7}$
Both Sexes ,, . .	$4\frac{1}{5}$	,, 1

For a mean of two years there are of assassinations among

	Men.	Women.	Children.	Total.
Peasants . . .	$101\frac{1}{2}$	$25\frac{1}{2}$	31	158
Free people . .	$19\frac{1}{2}$	$3\frac{1}{2}$	2	25
Military . . .	$10\frac{1}{2}$	$1\frac{1}{2}$	3	15
Nobility . . .	6	2	—	8
Clergy	$3\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{2}$	$5\frac{1}{2}$

The proportion among the sexes are, among the

Peasants.	Men to women .	4 to 1
	,, children .	3¼ ,, 1
	Women ,, .	1 ,, 1⅕
	Both Sexes ,, .	4⅒ ,, 1
Free people.	Men to women .	$5\frac{4}{7}$,, 1
	,, children .	9¾ ,, 1
	Women ,, .	1¾ ,, 1
Military.	Men to women .	7 ,, 1
	,, children .	3½ ,, 1
	Women ,, .	1 ,, 2
	Both sexes ,, .	4 ,, 1
Nobility.	Men to women .	3 ,, 1
Clergy.	,, ,, .	7 ,, 1
	,, children .	2⅓ ,, 1
	Women ,, .	1 ,, 3
	Both sexes ,, .	2⅔ ,, 1

The greatest number of these assassinations have been perpetrated by the fist or a stick, by people of low birth, in consequence of quarrels in the streets, inns, or roads. The peasant in Russia is not armed as he is in Spain, Portugal, and Turkey, and hence, when he commits murder, it may be in consequence of drunkenness or anger, he employs the first instrument he can lay his hand on to satisfy his feelings. The children who have perished by violence are principally illegitimate, and have been murdered by their mothers, not having the means of procuring admission for them into the government establishments. Those who have been murdered by the weapons mentioned, are enumerated in the following table:—

	Men.	Women.	Children.	Total.
Koursk	15	3½	1	91½
Moscow, government.	9	1	2	18
,, town . . .	—	1½	4½	
Riazan	10½	1½	2½	14½
Toula	7½	1½	4½	13½
Orel	8	3	2	13
Yaroslav	8½	1	2	11½
Vladimir	9	1	1	11
Voronega.	5	1½	2	8½
Kalouga	6	½	1	7½
Kostroma	3½	1	½	5
Total	82	17	23	122

Persons murdered by the knife or hatchet.

	Men.	Women.	Children.	Total.
Moscow, government.	8½	—	—	8½
,, town . . .	2	1	—	3
Toula	4	1½	—	5½
Riazan	3	1	—	4
Orel	3	½	—	3½
Koursk	2½	½	—	3
Kalouga	1	½	—	1½
Yaroslav	1	½	—	1½
Vladimir	1	½	—	1½
Kostroma	½	—	—	½

A very common method of murdering is, however, by strangling or choaking. In ten governments, twenty men, six women, and three children, suffered in this way. Only two cases of poisoning occurred.

The following table embraces in one view the various descriptions of murders:—

	Men.	Women.	Children.
Killed by fist or bludgeon .	92	17	23
Killed with knife or hatchet	26	6	—
Strangled or suffocated . .	20	6	3
Drowned	5	3½	10
Killed with fire-arms . . .	4	1	—
Poisoned	2	1	1
	149	34½	37

With regard to the state of families, we find that in Koursk, a father was assassinated by his two sons in 1822; a mother by her son, at Kalouga, in 1822. Five husbands were murdered by their wives, and twenty-three wives by their husbands.

At Koursk, a son was assassinated by his father in 1822, the only instance in ten governments. At Toula, in 1821, two brothers were killed by their brothers; and at Orel, in 1822, a similar instance of one person occurred. Among the clergy, at Vladimir, the wife of a deacon, in 1821, killed her son; in the government of Moscow the wife of an inferior, and in Toula, in 1822, the daughter of a priest killed their illegitimate children. In Moscow, in 1822, an uncle murdered his nephew. The same year, at Kalouga, a nephew killed his uncle; and at Koursk, in 1821, a grandfather his grandson. In 1822 there were twelve assassinations in families, while in 1821 there were only four.

The majority of perpetrators of murders, who amounted to 423 for two years, are unknown; 217 are in this state, but 206 have been discovered. Of this number, 127 were committed by peasants, in the governments of Riazan, Orel, Koursk, and Voronega; twenty by soldiers or deserters; seven by free people; six by employed persons; and four by the nobility. Eighty murders have been perpetrated by women, viz.: seventy-two children killed by their mothers in two years, five husbands by their wives, and three uncertain cases. The remaining 343 murders were committed by men.

The causes of these have generally been desire of gain, the vagabond life of deserters, melancholy, but above all, the gross manners of the lower classes. A peasant slew a guard of the forest in 1821, in Moscow, because he prevented him from escaping from the wood. A peasant of Vladimir, in 1822, killed another for having trampled on his rye. Murders on the high roads have generally been committed by soldiers who have deserted. In 1821, in Vladimir, three merchants slew three persons sent by their masters to transact some business.

In 1822, in Toula, two proprietors were killed by their domestic slaves from discontent. In 1821, at Riazan, a proprietor was murdered from an unkown cause. Similar cases occurred at Kostroma, Koursk, and Orel. At Koursk, in 1821, a peasant wishing to save another from recruiting, put poison in his ears, of which he died. Among the clergy there are five murders among the inferior grade. A person of noble extraction, employed at the manufacture of Toula, killed the person with whom he lodged, from hatred, in 1822. In three other cases, anger or drunkenness were the causes of murders.

ARTICLE III.

Notice of some Recent Improvements in Science.

(continued from p. 131.*)*

Compounds of Azote.—IN organic chemistry we can separate from one substance, by means of different re-agents, a number of bodies differing very materially in their nature from the substance in which they were previously combined. To ascertain if this fact held good in reference to inorganic substances, Liebig submitted to examination a ternary compound, which he formed in the following manner: (*Ann. de Chim.* lvi.) He passed through a solution of sulpho-cyanodide of potassium a current of chlorine gas. When boiled with dilute nitric acid an orange-yellow body precipitated, which, in its composition, was identical with the radicle of hydrosulphocyanic acid. Hence, he considered it as sulpho-cyanogen. This substance, when heated, is decomposed, and a quantity of sulphur and sulphuret of carbon comes off, while a yellow powder remains, which was employed by Liebig in his subsequent researches, Liebig terms this citron-coloured powder *mellon*. When exposed to a temperature at which glass melts, it is decomposed into pure cyanogen and azote. Analyzed with oxide of copper, carbonic acid and azote are procured in the proportion of 3 to 2. He considers it composed of

Carbon . .	458·622
Azote . . .	708·144
	1166·766

and explains its formation by conceiving 2 atoms of sulphuret of carbon = 2 C + 4 S and 4 atoms of sulphur to be subtracted by the heat from 4 atoms of sulpho-cyanogen, whose composition he states = 8 C + 8 A + 8 S. There remains therefore 6 C + 8 A.

Mellon, when heated in dry chlorine gas, combines with it and forms a white body, possessing a strong smell, and acting upon the eyes. The same substance may also be procured by heating together two parts chloride of mercury and one sulpho-cyanodide of potassium. Mellon may be produced by heating sulpho-cyanodide of potassium in a current of dry chlorine gas. With potassium mellon combines and forms a transparent easily fusible mass, which dissolves in water, imparting to it a taste of bitter almonds, precipitating the metals not as cyanodides, and is decomposed by the agency of acids.

2. *Melam*.—This substance is procured from hydro-sulphocyanate of ammonia, a salt which is formed by distilling together two parts of muriate of ammonia, and one part

sulpho-cyanodide of potassium. The composition of the hydro-sulpho-cyanate of ammonia is analogous with that of urea, sulphur being substituted for the oxygen of the latter. When heated, the first effect is to disengage a considerable quantity of ammonia, then sulphuret of carbon, and soon sulphuret of ammonia appears in the neck of the retort. After the distillation is over a new substance is observed in the retort, mixed with chloride of potassium and sal-ammoniac. By washing, the salts are taken up, and the grey matter called melam,, which remains, is insoluble in water, ether, and alcohol. It is frequently mixed with a little sulphur, which may be removed by levigation. It is decomposed by a strong heat into ammonia, cyanogen, and azote. If it is boiled in potash it readily dissolves, and the filtered liquor deposits a white granular matter, which is melam in a state of purity. Analyzed by means of oxide of copper, melam yielded,

Carbon . . .	30·550
Hydrogen . .	3·860
Azote	65·589
	100·000

When boiled with nitric acid it dissolves, and crystals of cyanuric acid are deposited on cooling. Fused with potash, cyanic acid is formed. Boiled with a solution of the same, and concentrated, it deposits crystals. The supernatant liquor retains a trace of this substance, which is precipitated by sal-ammoniac or carbonate of ammonia, affording a white gelatinous product, identical with the substance procured by treating melam with muriatic acid.

3. *Melamine.*—By this name Liebig distinguishes the substance which has just been described. To obtain it in a state of purity, he recomends taking the residue after the distillation of 2 lbs. sal-ammoniac, and 1 lb. sulpho-cyanodide of potassium, and adding to it a solution of 2 ounces of potash in 3 or 4 of water, and boiling them until the liquid be quite clear; after which it is to be filtered and evaporated gradually, when crystals of pure melamine are deposited. These crystals are octohedrons, with a rhombic base, in which the angles are about 75° and 115°. They are white, contain no water, and are not altered by the air.

Cold water dissolves very little melamine, but hot water readily dissolves it. Melamine combines with all the acids, and forms very characteristic salts. When heated with a solution of sal-ammoniac it gives out ammonia, and combines with muriatic acid. The sulphates and nitrates of copper, the salts of zinc, iron, manganese, are decomposed by a solution of melamine in water, and the oxides are precipitated. Fused with potash, cyanate of potash is produced; if it is in excess, mellonuret of potassium is formed. Liebig found the composition of melamine to be

Carbon . . .	28·460
Azote	66·673
Hydrogen . .	4·865
	100·000

Melamine, heated with nitric and sulphuric acids, yields ammonia, and a substance which remains dissolved in the acid, and is identical with the product of the action of concentrated acids upon melam.

Melamine has a strong affinity for sulphuric acid. The formation of needle formed crystals is the result of their combination, which are scarcely soluble in cold but easily soluble in hot water.

Nitrate of Melamine is readily formed by adding nitric acid to a cold solution of melamine in water, until the liquid be strongly acid. It is in the form of long needles. By combustion this salt gives carbonic acid and azote, in the proportion of 6 to 7.

When a solution of melamine is added to nitrate of silver a white crystalline precipitation ensues, which consists of

1 atom melamine . . .	16·
1 ,, nitric acid . . .	6·75
1 ,, oxide of silver . .	14·75
	37·5

Oxalate of melamine is less soluble in water than the nitrate. It affords, by analysis, carbonic and azote in the proportions of 8 to 6, and obviously consists of

1 atom melamine . . .	16·
1 ,, oxalic acid . . .	4·5
1 ,, water	1·125
	21·625

Acetate of melamine is very soluble in water, and crystallizes in large rectangular flexible plates.

Phosphate of melamine is very soluble in boiling water. A concentrated solution leaves, on cooling, a white mass formed of needles placed concentrically. *Formate of melamine* dissolves easily and crystallizes.

4. *Ammeline.*—This substance remains in solution in the caustic potash when melamine is prepared. It may be separated by saturating the alkali with an acid. It is best to employ acetic acid, because the mineral acids dissolve it in excess. Carbonate of ammonia and sal-ammoniac precipitate it also from its alkaline solution. After precipitation it should be washed and dissolved in nitric acid. Concentrate the solution and long four-sided colourless or slightly yellow prisms will be separated; or precipitate it from its solution in nitric acid by means of caustic ammonia, or carbonate of ammonia.

Ammeline is a white shining crystallized substance when precipitated by ammonia, insoluble in water, alcohol, and ether, but soluble in the caustic alkalies and in most of the acids. When heated it affords a crystallized sublimate of ammonia, and, if the heat is carried far enough, is converted into cyanogen and azote, leaving no residue. Towards acids it acts as a base, but it is weaker than melamine. Its salts are partially decomposed by water. Ammeline, analyzed by oxide of copper, afforded

Carbon	28·553
Azote	55·110
Oxygen	12·451
Hydrogen . . .	3·884
	100·000

Nitrate of ameline consists of

1 atom	ammeline .	16·
1 ,,	nitric acid .	6·75
1 ,,	water. . .	1·125
		23·875

Nitrate of ammeline affords with nitrate of silver, a precipitate of the same nature as that produced by melamine, being white and crystalline, and consisting of one atom each of ammeline, nitric acid and oxide of silver. Liebig explains the formation of ammeline and melamine, by considering that from 2 atoms of melam and the elements of 2 atoms of water, 1 atom of melamine and 1 atom of ammeline result.

By boiling melam with hydrochloric acid, ammeline and ammonia are produced by the aid of 2 atoms of water. Cyanate of potash is produced by the action of potash on dry ammeline, the cyanic acid in this case being formed by 1 atom of ammeline combining with 2 atoms of water, the resulting product being 3 atoms of acid.

5. *Ammelide* results from adding alcohol to a solution of melam or melamine in concentrated sulphuric acid. It precipitates in the form of a thick white precipitate. It may be also obtained by heating nitrate of ammeline till the soft mass becomes solid, or by boiling melamine in concentrated nitric acid. By boiling impure melam in dilute sulphuric acid, it dissolves, and crystals of sulphate of ammeline appear by evaporation, which are decomposed, if the liquid is boiled or further concentrated. Ammelide precipitates by the addition of the alkaline carbonates or alcohol. It is a white powder and seems a neutral body. Its composition corrected by theory is,

Carbon	28·444
Azote	49·410
Oxygen	18·606
Hydrogen . . .	8·538
	100·000

Liebig considers that it represents an anhydrous cyanate of ammonia or urea, which is deprived of all its water and the half of it ammonia. It is remarkable, that among the transformations of melamine, its saturating properties seem to diminish in proportion to the quantity of oxygen with which it combines. The same observation is applicable to vegetable bases, as for example, narcotine and solanine whose basic functions are not well characterized, but which are distinguished from the stronger bases by containing a greater proportion of oxygen.

6. *Cyanilic acid.*—If the yellow powder which is obtained from the decomposition of sulpho-cyanodide of potassium

by chlorine, and which is mixed with chloride of potassium, be well washed and boiled with nitric acid, it dissolves gradually, and the liquid on cooling deposits colourless and transparent octahedrons with a square base, which consist of pure cyanilic acid. To accelerate the decomposition of the salt of potash, it is advantageous to add twice its weight of common salt. At first chloride of sulphur distils over, and latterly long needles of chloride of cyanogen are deposited in the neck of the retort. The yellow residue is carefully washed and dissolved in nitric acid. The new acid is more easily soluble in cold water than cyanuric acid. The crystals contain water which they lose by heating, to the amount of 21 per cent. Its composition is,

Carbon	28·185
Azote	32·640
Oxygen	36·874
Hydrogen	2·300
	100·000

which Liebig considers equivalent to 6 atoms of each. To determine the atomic weight of the acid, a portion was neutralized by ammonia, and precipitated by nitrate of silver. 93·3 cyanilate of silver afforded 54·5 chloride of silver. 58·2 after being exposed to a red heat, left 26·4 silver. Hence, the atomic weight of the acid is 16·25 or double that of cyanuric acid, which it very much resembles in its properties. Cyanilic acid is converted into cyanuric acid by dissolving it in sulphuric acid, adding water and crystallizing. All the cyanurates and cyanilites are decomposed when they are crystallized in an acid liquor; the bases remain in solution, and the crystals which are formed are cyanuric acid or cyanilic acid. In precipitating the nitrate of silver by cyanilate of potash, Liebig obtained a substance which had precisely the same composition as cyanurate of silver, from which it would appear that the alkalies can change cyanilic into cyanuric acid.

7. *Chloride of Cyanogen.*—During the decomposition of sulpho-cyanodide of potassium by chlorine, besides chloride of sulphur, chloride of cyanogen distils over, which may be separated from the former by sublimation in a vessel through which a current of dry chlorine is passed. Chloride

of cyanogen thus obtained consists of brilliant needles, possessing a strong disagreeable odour. To determine the quantity of chlorine, the salt was dissolved in alcohol, ammonia was added, and the liquid boiled with a great quantity of water until all the spirit was volatilized.

Nitric acid was then added in excess, and precipitation produced by nitrate of silver. The composition of the chloride of cyanogen was in this manner determined to be

Chlorine . . .	57·03
Cyanogen . . .	42·97
	100·00

or equal atoms of chlorine and cyanogen. Chloride of cyanogen dissolves in absolute alcohol without alteration.

8. *Cyanamide.*—If chloride of cyanogen is moistened with ammonia, and gently heated, it loses its crystalline form, and is reduced to a white powder, which is slightly soluble in boiling water, and is precipitated on cooling in flocks. The same substance is obtained by passing ammoniacal gas over chloride of cyanogen in powder. A white powder is the result, which may be purified by washing. The chlorine which it contains is not removed by ammonia. Potash disengages ammonia from cyanamide. Liebig considers it analogous in its composition to oxamide, and to a chloride of cyanogen.

Uric Acid.—Liebig states that he was encouraged to make the preceding researches in the hope of finding a new combination which would throw some light upon the composition of uric acid. Liebig considers the determination of Dr. Kodweiss, with respect to the proportion of azote, to be nearer the truth than any other. He himself makes the composition of uric acid:

	Calculated.		Experiment.
Carbon . . .	36·11	-	36·073
Azote	33·36	-	33·361
Oxygen . . .	27·19	-	28·126
Hydrogen . .	2·34	-	2.441

Method of procuring Oxide of Chromium in Crystals.—Wöhler has found that the green oxide of chromium, which is well known as a green powder, may be obtained in the state of crystals by passing the vapour of chloro-chromic acid through a red hot glass tube.* A mixture of chlorine and oxygen is formed, and the crystals of oxide are deposited in the tube. Thus prepared, it is not green but black, possessing the metallic lustre, and has the same form as native peroxide of iron, (*fer oligiste* or rhombohedral iron ore) which he considers a proof of the ismorphism of these two oxides. The spec. grav. in the crystallized state differs little from that of peroxide of iron, being 5·21.

It scratches rock crystal, hyacinth, and cuts glass. In the crystallized state it is therefore as hard as corundum, which, with the exception of the diamond and rhodium, is the hardest of known substances. Chloro-chromic acid was discovered by Professor Thomson in 1824, and is prepared by distilling in a glass retort 500 gr. sulphuric acid, with 190 gr. dry bichromate of potash, and 225 gr. of decripitated common salt. According to Dr. Thomson, it consists of one atom chlorine, and one atom chromic acid. Rose considers it a combination of two atoms chromic acid and one perchloride of chromium. Wöhler prepares it by distilling ten parts common salt, 16·9 neutral chromate of potash, and thirty parts of concentrated sulphuric acid.

SALTS.

Crenate of potash and crenate of soda form a yellow extract looking mass, which becomes hard and cracks, and is neutral to test-paper; soluble in absolute alcohol; scarcely soluble in spirits of the sp. gr. 0·86. When heated gives out fumes smelling of tobacco, and leaves alkaline carbonates.

Crenate of Ammonia leaves in the air a brown extractive matter which reddens litmus paper. In this state it contains much ammonia, which may be separated by potash or lime.

Crenate of barytes is so slowly soluble in water that it may be precipitated in a yellow flocky state, but is dissolved by the addition of more water, and leaves a kind of varnish on the vessel.

Crenate of lime is more easily soluble, but can be precipitated. Its solubility is much affected by the presence of other salts. It precipitates in pale yellow flocks, when a solution of alkaline crenate is mixed with a solution of chloride of calcium. The solution of this salt leaves behind it a yellow transparent varnish. It dissolves completely in water. When the neutral salt is mixed with excess of acid, evaporated, and then treated with alcohol, a pale yellow acid salt remains, easily soluble in water. A basic salt is obtained by mixing lime-water with the neutral salt.

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* Ann. de Chim. lvii. 105.

Crenate of Magnesia is very soluble in water.

Crenate of Alumina is insoluble in water, but the acid salt is soluble. Ammonia does not precipitate the base, but affords a double salt by evaporation, which is soluble, and affords pure alumina by calcination. The neutral crenate has a portion of its alumina precipitated by ammonia.

Crenate of Manganese is a pale yellow powder.

Crenate of Iron is soluble in water. It may be obtained from the ochre, by mixing the latter with water, and passing a current of sulphuretted hydrogen through it. By evaporation in a place free from air this salt remains.

Percrenate of Iron may be formed by adding crenic acid to a solution of sulphate or chloride of iron. It is dirty-white when dry, and earthy reddish-gray when moist. It dissolves completely in ammonia.

Crenate of Lead is produced when crenic acid is poured into a strong solution of acetate of lead as long as the resulting precipitate exhibits a brown or dark-yellow appearance. When this ceases, the crenic acid is to be dropped into the acetate of lead, the precipitate washed with water, or rather with alcohol, and dried in a receiver, over sulphuric acid. When dry it is a light-gray powder, and is to a certain extent soluble in water. It is also soluble in acetic acid, and somewhat in crenic acid.

Crenate of Copper is precipitated from the acetate, but not from the sulphate, by crenic acid. The precipitate is at first dirty-white, and then light-gray, with a yellowish green tinge. It is little soluble in water. Its precipitation is not complete in the cold, but is fully effected at a temperature of 50° (122° F.)

An acid salt is formed by the addition of crenic acid to the neutral salt. It is a gum like mass, insoluble in alcohol.

Crenate of Mercury forms a yellow flocky precipitate, and is formed in a solution of nitrate of mercury, by crenic acid, or its soluble salts.

Crenate of Silver is formed by dropping crenic acid into a solution of nitrate of silver. It is a grayish white matter, becoming purplish after some time. The water of Porla becomes red by the addition of nitrate of silver, which is obviously owing to the re-action of the crenic acid.

The alkaline *apocrenates* can be best formed by pouring apocrenic acid into the solution of an alkaline acetate, and extracting the alkaline acetate remaining, after evaporation, with alcohol. The matter produced forms a blackish mass, which gives a brown tinge to its solution in water.

The ammoniacal salt becomes acid by evaporation, dissolves readily again in water, and reddens litmus paper; 100 parts of dried apocrenic acid, at 212° F, give, after solution in ammonia, and evaporation in the water bath, 113·22 parts. Considering this to contain an atom of water and one of ammonia, and to constitute a biapocrenate of ammonia, the numbers, according to the previously ascertained atomic weight, would be 112·98.

The earthy apocrenates are dark-brown precipitates, which, by washing, form a yellow solution. If the solution is evaporated a brown residue remains, which is again soluble in water. With excess of base an insoluble salt is formed.

When apocrenic acid is added to the hydrate of alumina in excess, the acid will be precipitated. With a small portion of hydrate, apocrenate of alumina is obtained in solution. When an alkaline apocrenate is digested with the hydrate, it is so completely precipitated that the solution loses its colour, and contains only a trace of crenic acid.

The precipitate is brownish black, and is a double salt.*

Apocrenate of Copper, when precipitated out of an acetic acid solution, with excess of the latter, is acid possessing a brown colour, and having a slimy consistence. It is soluble in small quantity in pure water. By adding to this solution alkali the neutral salt precipitates. It forms double salts with ammonia and soda.

Apocrenated Protoxide of Iron is soluble in water, but by exposure to the air is converted into the peroxide salt. The latter is a black flocky precipitate, soluble in caustic ammonia, and giving a dark colour to the solution. After evaporation to dryness, a dark extract looking mass remains, from which water dissolves a neutral double salt, and leaves a basic oxide salt. Caustic potash likewise dissolves the perapocrenate of iron, but a precipitate soon subsides, the apocrenate of potash being dissolved in the solution, and a basic salt separating. The solution may be freed completely from iron, by passing a current of sulphuretted hydrogen through it, but in no other way can the iron be entirely precipitated.

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* Whether the atomic weight of apocrenic acid is 16·5 or 16·75, must be determined by future experiments.—EDIT.

Croconate of Potash may be formed by passing carbonic oxide through a glass tube over fused potassium. When exposed to the air the compound inflames with explosion, and dissolving in water, and affording, by evaporation, long prismatic needles of croconate of potash. It consists of

Carbon . . .	27·83
Oxygen . . .	29·17
Potash . . .	43·00
	100·00

Vermilion.—According to Wehrlé, vermilion similar to that of China can be made by the following process:—Sublime common vermilion, in very fine powder, with the hundredth of its weight of sulphuret of antimony, then digest the sublimate with the sulphuret of potassium, and afterwards with muriatic acid, and lastly, with ¼ per cent. of gelatine, dissolved in water; wash and dry it; a very small portion of sulphuret of antimony is sufficient to impart to the vermilion a beautiful crimson colour. (*Poggendorff*, *Ann.* xxvii.)

Potash Cyanide of Iridium.—This salt, which crystallizes in long four-sided prisms, resembling gypsum, was obtained by Mr. Booth of Philadelphia, by heating a mixture of anhydrous potash cyanide of iron with powder of iridium. The salt is colourless, soluble in water, insoluble in alcohol, is not precipitated by muriatic acid, and contains no water. By heating it becomes black, and, if the heat is pushed farther the iridium separates.

VEGETABLE BODIES.

Sugar of Secale Cornutum, (*Jahresbericht*, 1834, 275.)—Wiggers describes a species of sugar obtained from this fungus, by treating it with water and alcohol, which crystallizes in four-sided prisms. It is transparent and colourless, soluble in alcohol and water, insoluble in ether. Forms oxalic acid when nitric acid is poured on it, but does not decompose by boiling the acetate of copper. It is very similar to the mushroom sugar, only the latter crystallizes in right angled prisms.

Starch.—The French chemists have been much engaged with investigating the composition of this important substance. Their exertions deserve praise, for it is quite obvious that an accurate knowledge of its nature must precede any great improvement in the conversion of its elements into several important luxuries of life. M. M. Payen and Persoz describe a substance procured from it to which they apply the term *diatase*, possessing very powerful properties. It is procured by bruising in a mortar fresh sprouted barley, moistening it with half its weight of water, and submitting it to pressure. The liquid which separates is mixed with a quantity of alcohol sufficient to destroy its viscidity, and precipitate the azotized matter, which is separated by filtration. The filtered solution precipitated by alcohol affords impure diatase, which is purified by three additional solutions in water and precipitations. It is then collected on a filter, and dried in a thin layer on a plate of glass by a current of hot air, and lastly, pulverized and placed in well stoppered flasks. *Diatase* has no action upon the fibrous matter, inuline, gum-arabic, lignine, albumen, gluten, tannin, or animal charcoal, but upon fecula it possesses a most wonderful action, dissolving two thousand times its weight of fecula in four times the weight of water, at a temperature between 149° and 161°.

The fecula, according to the same chemists, consists of 99·5 parts of a substance which they term *amidone*, and 0·5 fibrous matter. *Amidone* is procured by boiling for some minutes a mixture of one part of fecula in 100 parts of water, passing through a double filter, evaporating rapidly and drying it in thin slices. By taking it up with cold water, filtering, evaporating, and drying, the substance is obtained, mixed with some impurity, which may be removed by digestion in cold water, and solution in hot, at the temperature 176°, and drying it in vacuo after repeating the process several times. *Amidone* is insipid, neutral, colourless, diaphanous, elastic, absorbs moisture from the atmosphere; dissolves in water of the temperature 149°, but is not acted on by cold water unless the two be agitated together, when a notable portion is taken up. It is insoluble in alcohol, which extracts some essential oil, and precipitates it from its aqueous solution. If a solution of tannin be poured into an aqueous solution of *amidone*, a copious milky precipitation ensues, which is re-dissolved by an excess of the latter. Iodine forms with it a blue compound, which is insoluble in water below the temperature 149°; gelatinous alumina, animal charcoal, phosphate of lime, and isinglass, remove it from its mixture in water, and several acids and salts produce the same effect.

A number of experiments, made by the authors, prove that the *amidone* of the fecula and of the incomplete re-action of *diatase* only differs in its degree of division. Barytes forms a white bulky precipitate in a solution of *amidone*. *Subacetate of lead* affords an insoluble precipitate, as well as lime water.

If to fecula, mixed with five times its weight of water, we add 0·005 of diatase, at the temperature 158°, the whole of the *amidone* is destroyed, as may be proved by the absence of any action upon adding iodine. It is converted into sugar and gum, which are distinguished from the substance from which they were produced, by being soluble in water and weak alcohol, in not being precipitated by tannin, subacetate of lead, or any of the re-agents mentioned. Alcohol of ·816 to ·794 does not dissolve them. The gum and sugar are distinguished from each other by the sugar dissolving in alcohol of ·850, without leaving any residue, while gum is precipitated by the same agent.

The sugar, by the agency of yeast and heat, is converted into alcohol and carbonic acid, while the gum of *amidone*, under the same circumstances, does not produce alcohol, but by the action of sulphuric acid it is converted into sugar. According to Biot, the gum obtained from fecula, by means of diatase, produces on the plane of polarization rotation to the right. The authors propose to retain for it the term *dextrine*, or gum dextrine.

The fibrous parts of fecula are kept together by interposed *amidone*, and various bodies adhere to this envelope, as carbonate and phosphate of lime, silica, and essential oil. If the temperature of the fecula is gently raised in water to 202° the amidone swells and ruptures the envelope, producing starch.

The authors conclude with some important deductions from their experiments. In laboratories, and in rural economy, they suggest that *diatase* will be useful for the analysis of fecula, flour, bread, and different amylaceous substances, but more particularly, will be found an elegant method of analysing organic substances. The same substance presents us with the means of obtaining the dextrine and fibrous matter free from *amidone;* of procuring the latter substance in abundance, and of converting it into gum and sugar. M. Serres has employed dextrine in the great hospitals at Paris, as a substitute for gum-arabic, with success, as it is destitute of the insipid taste of that substance,

M. Guerin Varry has obtained very different results from his analysis of starch, which by no means hold out to us the same prospects, but, as great care seems to have been employed on both sides, we do not hesitate to give place to the experiments of each, as we consider the subject still clouded with a few ambiguities.

We confess, however, that Varry's reasons for considering the substances which he describes as distinct, are far from being conclusive.

*Amidine** forms, according to M. Guerin Varry, one of the constituents of starch. The method of obtaining it is to boil, for a quarter of an hour, one part of the fecula of potatoes in 100 parts of water, pour the liquid into a deep vessel, allow it to stand till the tegumentary matter is deposited, decant the fluid, filter it, and evaporate it by slow boiling, to the consistence of a syrup. The residue is then to be thrown on a linen cloth, which retains the *amidine*, and allows a liquid to pass, which on evaporation at a temperature below 212°, still deposits *amidine*. To separate this it is necessary to filter again and evaporate, and this treatment should be repeated four times. A liquid is thus obtained, which, on evaporation to dryness, leaves a residue completely soluble in cold water. This new solution is deprived of its colour by animal charcoal, purified and precipitated by alcohol. The precipitate is thrown on a filter and washed with alcohol at the temperature 176°; it is then dissolved in the least possible quantity of hot water, and the liquid submitted to a gentle heat. The substance thus obtained consists of

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* Ann. de Chim. ch. de phys. lvi. 225.

Water	3·00	Oxygen	53·15
Ashes	0·20	Carbon	39·72
Amidine	96·80	Hydrogen	7·13
			100·00

It possesses a slightly yellowish colour when dry; white when hydrous, and is destitute of taste and smell. In thin portions it is transparent, and is easily reduced to powder. M. Biot found, on examining an aqueous solution of *amidone*, that it produced upon the polarized rays of light a deviation towards the right three times as great as cane sugar. When heated in the air or in vaccuum, it fuses, swelling up, without volatilizing. Cold water dissolves it completely, becoming very mucilaginous, but it is more soluble in hot water. It is insoluble in alcohol and sulphuric ether. It adheres so powerfully to the porcelain vessels in which it is evaporated, that, in Varry's experiments, the glaze was frequently removed although great precautions were employed. The aqueous solution becomes acid in some days. Nitric and muriatic acids produce in the cold with *amidine* solutions which are coloured strongly blue by iodine. It is not so soluble in sulphuric acid. Its solution in potash, when neutrallized by an acid, is coloured blue by iodine, which detects the presence of *amidine* in a solution containing but a minute quantity of it. Nitric acid converts it into oxalic acid; 100 parts of *amidine* and 250 parts of sulphuric acid, at C 150°, affords 95·80 parts of anhydrous sugar. The *dextrine* of Biot and Persoz appears to be an impure substance containing *amidine*.

Fibrous amidine (amidine tegumentaire) is procured by boiling one part of fecula with 200 parts of water, for a quarter of an hour, and allowing the fibrous matter to be deposited. The supernatant liquor should then be decanted, and the fibrous matter again boiled with the same quantity of water, and for the same length of time. This treatment is to be continued until the filtered liquid, after evaporation to dryness, leaves no residue, which is turned blue by iodine. The matter is then dried by a moderate heat. When dried at a temperature below 212° it possesses a slightly yellow colour, and presents the appearance of small pellicles, mixed with small lumps, easily pulverized. It is destitute of taste and smell, and has no action on test paper. In an aqueous solution of iodine a fine blue colour is occasioned when this substance is introduced, which disappears by heating the solution up to a temperature of 194°, but re-appears on cooling. When kept for 100 hours in 10,000 times its weight of boiling water, it is not converted into globules, as has been stated by Raspail, Biot, and Persoz. It is insoluble in cold and boiling water, alcohol, and sulphuric ether. In contact with water it swells, becomes white and elastic; 100 parts of *insoluble amidine*, gently heated with 800 parts of nitric acid, produce 25·46 parts of anhydrous oxalic acid. If 1 part *amidine* is digested with 2½ sulphuric acid at 150°, after twelve hours a syrup is obtained, which, when boiled with 200 parts of water for two hours, is converted into sugar of starch and *vegeto sulphuric* acid.

Varry finds the composition of *fibrous amidine* and *woody fibre*, or *lignine*, almost identical. The constituents of these substances are

	Oxygen.	Hydrogen.	Carbon.
Fibrous Amidine	40·67	6·59	52·74
Lignine	41·78	5·69	52·33*

Hence, I think there is very great propriety in his query. Is not *fibrous amidine* merely woody fibre combined with a small quantity of amidine, which exhibits an action on iodine? The author, however, is rather inclined to consider these substances as different, and to explain their similarity on the principle of *isomerism*, a term which, like that of *nervous* in medicine, is now employed on the Continent to explain all difficulties in reference to analogous compounds.

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[*] By the analysis of Gay, Lussac, and Thenard.

Varry describes a *soluble amidine* which he considers to be *fibrous amidine* held in solution by *amidine.*

Starch, he states, is therefore composed of 2·96 parts of *fibrous amidine*, and of 97·04 parts of a soluble substance which contains an insoluble matter, identical with fibrous amidine, and a soluble matter or *amidine.* This is to the soluble amidine as 60·45 to 39·55.

Lichenine, is the name which M. Varry gives to the soluble part of the *lichen Islandicus, (cetraria Islandica.)* He prepares it in the manner indicated partly by Berzelius, viz: allowing the lichen to remain twenty-four hours in contact with water and potash of commerce, in the proportion of 1 lb. lichen, 18 lbs. water, and 1 oz. potash; the liquid becomes brown, the lichen is placed on linen and then macerated with a new quantity of water, and this is continued till it becomes bitter and alkaline. The lichen is boiled with 9 lbs. of water down to ⅔, the hot solution is passed through linen, and the residue expressed. Varry treats this residue twice with three times as much water as the lichen employed. The jelly thus prepared was dissolved in boiling water, and passed through a filter. The solution was precipitated by alcohol; the precipitate re-dissolved in water at 212°, and the liquid evaporated to dryness by heat. When thus obtained *lichenine* is yellowish when dry, colourless when hydrous. It is destitute of taste and smell, transparent in thin portions, and is not easily pulverized. In cold water it swells, and scarcely dissolves in this fluid at the ordinary temperature; but is completely soluble at 212°, and forms with it a very thick mucilage. It colours iodine blue, but has not such a powerful effect as an equal quantity of amidine. From its aqueous solution it is precipitated by alcohol and sulphuric ether.

Subacetate of lead precipitates it abundantly, insoluble in cold water, but soluble in a few drops of acetic acid. An aqueous solution becomes acid by standing, evaporated at a temperature below 212°, pellicles form on the surface, which are completely soluble in boiling water. 100 parts of lichenine at 150°, and 250 sulphuric acid produce 93·91 parts of anhydrous sugar. Nitric acid by its action on *lichenine* produces no mucic acid; hence, there is no arabine present in it.

M. Varry has made an interesting observation in reference to the action of this acid upon lichenine, by which oxalic acid may be formed at a much cheaper rate than it is at present. He digested 100 parts of *lichenine* with 600 parts of nitric acid of sp. gr. 1·34, and at the end of 28 days formed a quantity of *hydroxalic* acid; this is easily converted into oxalic acid, for if the temperature is raised from the ordinary heat of the atmosphere to 140°, crystals of oxalic acid are deposited equivalent to 48·17 parts for 100 *lichenine*. The composition of *lichenine* is

Oxygen . . .	53·43
Carbon . . .	39·33
Hydrogen . . .	7·24
	100·00

being analogous to amadine.

Picrolichenine. (*Jahresbericht*, 1834, 319.)—In the *Variolaria amara* Alms has discovered this substance which crystallizes and communicates to that lichen its bitter taste. The lichen is boiled with rectified spirits, the solution distilled to three-fourths, and the remainder allowed to evaporate spontaneously. In the course of a week, picrolichenine separates in crystals. These can be most effectually separated from the thick mother liquor by treating them with caustic potash ley, dissolving them in alcohol and crystallizing. The crystals are in the form of transparent colourless four-sided double pyramids with rhombic bases, destitute of smell, but possess a strongly bitter taste. Sp. gr. 1·176. Melts at 212°. Gives no trace of ammonia by dry distillation, but the usual products. Insoluble in cold water, slightly so in hot water. Soluble in alcohol, from which solution, it is precipitated by water in flocks. It is dissolved also by ether, volatile and fat oils, ammonia, sulphuric and acetic acids. From the two latter, it is precipitated by water. Alms recommends it in small doses as an efficacious remedy in intermittent fever.

Ergotine, (*Berzelius Jahresbericht*, 1834, 319.)—Wiggers has extracted a principle from the *secale cornutum*, which he terms *ergotine*. The ergot of rye is treated with ether and alcohol, and the solution evaporated. The ergotine remains in the form of a reddish brown powder. By heating it gives a peculiar smell, and tastes aromatic and bitter. It is neutral, insoluble in water and ether, soluble in alcohol, from which solution it is precipitated by water in reddish brown flocks. By chlorine it is bleached. By sulphuric acid dissolved, and again precipitated by water. Caustic potash, but not carbonate of potash, dissolves it. It is decomposed by nitric acid, but the product is nether oxalic nor mucic acids.

Cerine Ceraine and Myricine.—Ettling (*Ann. der Pharmacie*, ii. 265.) obtained cerine from wax by alcohol. It was crystalline, colourless, and consisted of, Carbon 78·862. Hydrogen 13·488. Oxygen 7·647. From the cerine, ceraine was formed by drying and pulverizing the mass, treating the margaric salt with alcohol, and afterwards the residue with water, and then boiling in dilute muriatic acid, evaporating to dryness, boiling in alcohol and allowing crystals to form by cooling. The crystals melted on the sand bath to free them from moisture yielded, Carbon 80·44. Hydrogen 13·75. Oxygen 5·81.

Myricine, or the portion of wax insoluble in alcohol of 0·833 was dissolved in boiling absolute alcohol; after cooling, the product deposited was melted and analyzed. It gave Carbon 80·01. Hydrogen 13·85. Oxygen 6·14.

Principle in Sarsaparilla.—According to Thubery a crystalline substance exists in the sarsaparilla root which is taken up by alcohol. 10 pounds of the root contain 3 oz. 1 dr. of the substance which is colourless and tastless, soluble in alcohol and water. On charcoal it burns with the smell of benzoin.

Struthiin, (*Jachresbericht*, 1834, 316.)—Bley has obtained from the root of the *gypsophila struthium*, commonly termed radix saponariæ levanticæ, a substance which he terms *Struthiin.* The bruised root was freed from oily matter by ether, and afterwards digested in absolute alcohol. This solution was distilled in the water-bath till the liquid amounted to a small quantity, and was then evaporated in the air. By cooling, struthiin was deposited in white flocks, which, when dry, form in yellow pieces. Struthiin is destitute of smell, has a sweetish, mucus taste. It is not volatile, but is inflammable, and burns with flame. It is soluble in water, which it makes frothy like a solution of soap. It is insoluble both in hot and cold absolute alcohol, but somewhat soluble in alcohol containing water, insoluble in ether. It is decomposed by hot sulphuric acid, but is not dissolved by muriatic acid. The root contains $\frac{4}{5}$ per cent. of *struthiin.*

Eight months after the experiments of Bley were made, M. Bussy published an analysis of the same root, and termed the principle *saponin*, which he found to consist of

Carbon . . .	51·
Hydrogen. . .	7·4
Oxygen . . .	41·6
	100·0

but he observes that this is merely to be considered an approximation.

Various Vegetable substances, (*Ann. de Chim.* i. 197.)—Pelletier has analyzed a number of vegetable substances, and obtained the subsequent results :—

	Azote.	Carbon.	Hydrogen.	Oxygen.
1. Oily matter of opium .		72·39	11·82	15·78
2. Caoutchouc of opium .		87·89	12·11	—
3. Santaline		75·03	6·37	18·60
4. Olivile		63·84	8·06	28·10
5. Sarcocolline,		57·15	8·34	34·51
6. Piperine	4·51	70·51	6·80	18·28

1. The oily part of opium which remains after the evaporation of the ether solution, is mixed with narcotin and caoutchouc. From the latter it may be separated by alcohol, and from the former by muriatic acid.

3. Constitutes the colouring matter of sandal wood.

4. The sap of the Poenea mucronata produces sarcocoll, and from the latter the sarcocolline was extracted, first by heating it with ether, and then with absolute alcohol.

Benzine.—When bénzoate of lime is subjected to distillation at a temperature of 300°, (572° F.) a brown oily matter, denser than water, comes over, and carbonate of lime remains. If this oil be distilled on the sand bath, a limpid oil passes over, which is lighter than water, and possesses the smell of bitter almonds, and boils at 82°, (179° F.) By continuing the process water is produced, and a second oil, which boils about 250°, (482° F.)

1. It holds in solution a third substance, which has a white colour, and crystalline structure. It is naphthaline. The oil, at 20°, assumes the appearance of an emulsion, and is termed by Peligot benzone, in conformity with acetone and margarone. Benzone consists of

Carbon . . .	86·5
Hydrogen . .	5·4
Oxygen . . .	8·1
	100·0

It is a thick oil, colourless when pure, but generally possesses an amber tint, with a slightly empyreumatic smell, and it is lighter than water. It is not attacked by nitric acid and potash, but is decomposed by sulphuric acid.

2. The naphthaline is perfectly white, fuses at 78°, (172° F.), boils at 210°, (410° F.), and consists of

Carbon . . .	93·86
Hydrogen .	6·14
	100·00

3. The oil procured by the gentle distillation is colourless, lighter than water, boils at 82° (179° F.) and possesses an aromatic smell. It consists of

Carbon . . .	92·45
Hydrogen. . .	7·55
	100·00

and is therefore a bicarburet of hydrogen.

Peligot conceives, however, that if the decomposition of the benzoate of lime could be effected at a moderate temperature, nothing but benzone would be produced, and carbonate of lime would remain. The formula for benzoate of lime according to the experiments of Wöhler and Liebig will be: $14\,C + 6\,H + 40 + C$.

If we take from this an atom of carbonate of lime, we have remaining for the composition of benzone,

$13\,C + 6\,H + 2\,O$, (*Ann. de Chim.*, lvi, 59.)

Mitscherlich* has examined the same substance under the name of benzine, and considers it the base of benzoic acid, which is therefore a combination of benzine and carbonic acid.

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* Pogg. Annal. xxix. 231.

Peligot states that benzone distilled with quick lime produces carbonate of lime and naphthaline, and that in distilling hydrous benzoic acid with lime in excess, bicarburet of hydrogen is the only product.

Nitro-benzide, is the name given by Mitscherlich to the product of the action of fuming nitric acid upon benzine. It is a yellowish coloured substance, possessing a sweet taste and peculiar smell somewhat between that of bitter almonds and oil of cinnamon. Its spec. grav. is 1·209. Its boiling point is 415°. At 37° it begins to solidify, and crystalline needles are observed. Sulphuric acid decomposes it. It detonates when heated with potassium. It is almost insoluble in water, and completely so in ether and alcohol. Concentrated nitric and sulphuric acids dissolve it easily, It consists of

Carbon . . .	58·53
Hydrogen . . .	4·08
Azote	11·20
Oxygen . . .	25·99
	99·80

Sulpho-benzide, is procured by the following process. Expose benzine to the action of anhydrous sulphuric acid, or acid of Nordhausen until a thick liquid is produced, which dissolves completely in a little water. Saturate the acid with barytes, and decompose the salt of barytes in solution with sulphate of copper; after evaporation, sometimes crystals of the copper salt are obtained, and sometimes sulpho-benzoate of copper; and in addition, a crystalline powder separates when the liquid is reduced to dryness. This substance is very slightly soluble in water and may be completely freed from the acid which it retains by repeated washing in the water; but to have it in a state of absolute purity, it should be dissolved in ether, the solution filtered, evaporated, and the resulting crystals subjected to crystallization. At 212° it becomes a transparent colourless liquid, and boils at a temperature between the boiling points of mercury and sulphur. It is destitute of taste and smell, insoluble in alkalies, soluble in acids, from solutions in which it is precipitated by water. With sulphuric acid it forms a peculiar acid, which forms a soluble salt with barytes. It suffers no alteration when distilled with nitrate or chlorate of potash. It detonates with saltpetre at a red heat, and also with chlorate of potash at a very high temperature. At the ordinary temperatures chlorine and bromine have no action on it, but at the boiling temperature chloride of benzine is formed, and in this way the quantity of oxygen contained in it was determined. It is composed of

Carbon . . .	66.42
Hydrogen . .	4·52
Sulphur . . .	14·57
Oxygen . . .	14·49
	100·00*

Madder is such an important article in the art of dyeing, that its proper culture and natural history have justly attracted the attention of chemists. Schlumberger, a German, has lately published an account of a series of experiments, which he has made for the purpose of determining the causes of the difference between the madder of Alsace, and that raised in Avignon, from which he has inferred, that carbonate of lime is indispensable, that, when we wish to dye red and violet colours with madder upon cotton with an alum or iron mordant, if we use Avignon madder the addition of lime is in general unnecessary, because it naturally contains carbonate of lime, except in a few instances where the plant has been raised on a soil containing little calcareous matter; while the Alsace madder which contains only a small portion of lime, although it can produce as deep a shade as the former, yet does not form so permanent a colour; but when lime has been added, the dye is equal to that of Avignon. Besides lime, there are several other substances which produce standing colours with madder These are in the order of their power, carbonate of lime being the best, phosphate of lime, carbonate of magnesia, hydrous protoxide of lead, protoxide of zinc, carbonate of zinc, protoxide of manganese, hydrous peroxide of manganese, hydrous protoxide of cobalt, acetate of lime, and phosphate of cobalt. The Avignon madder loses its permanence when treated by acid which dissolves the salt of lime.

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* Ann. de Chim. lvii. 85.

M. Robiquet, who along with Colin and Logier has been paying much attention to the subject, although he does not deny the truth of the facts to a certain extent, brought forward by the German chemist, ascribes them to a different cause. He affirms, that lime is not necessary for obtaining permanent madder colours, and indeed, that its presence impedes good dyeing. He has found in madder two colouring matters, *alizarine* and *purpurine*, which vary in their relative proportions, according to the nature of the soil, the cultivation, climate, and age of the root. In most of the acids, *alizarine* is insoluble, so that when an acid is present, this colour cannot be fixed. The Avignon madder contains no free acid, while the Alsace madder does, as is apparent from its yellow colour. The latter contains much *purpurine*, and is therefore, better fitted than the Avignon madder, for dyeing lake colours, the agent necessary being *purpurine*. A hot solution of alum dissolves the *purpurine*, and does not attack the *alizarine*, which is remarkable, because, when the latter has once combined with alumina, the affinity is very strong. Robiquet, infers therefore, from these circumstances, that it is not the same colouring matter which becomes alternately fixed or fugitive, according to the presence or absence of chalk, but that it is owing to the existence in the madder of two distinct colouring matters, one of which, the *purpurine* is soluble in acids, and can therefore, readily be brought in contact with the mordant, while the other requires neutrallization, previous to solution. Robiquet found that during boiling, carbonic acid was extracted from madder, which he considers as being either present naturally, or as being formed by the alteration of some of the principles during the process. At a temperature of about 300°, not only carbonic acid, but acetic acid also, without oil was discharged. Robiquet conceives, that the fine colour of Turkey red is owing to the combination of the two colouring matters, and that the fixation of the purpurine is to be ascribed to the oil, (*Ann. de Chim.* lvii. 70.)

Oil of Wax.—Ettling has examined the oil of wax after freeing it from paraffine and margaric acid. Red oil of wax was distilled with four parts of water to one half. It was then digested with potash, which removed a brown matter, and afterwards distilled and rectified with muriate of lime. It became pale-yellow; sp. gr. 0·7502; boiling point 137° (278° F.) It consists of

Carbon . . .	85·535
Hydrogen . .	14·224
Oxygen . . .	0·241
	100·000

Annalen der Pharmacie.

Products of the decomposition of alcohol, by peroxide of manganese and sulphuric acid. (*Ann. de Pogg.* xxviii. 508.) C. G. Gmelin announced that when alcohol is distilled with peroxide of manganese and sulphuric acid, formic acid was formed, but Döbereiner disputed the fact. M. L. Gmelin, to settle the matter, distilled two parts of alcohol with four of water, two of sulphuric acid, and two peroxide of manganese. He obtained as the product, pure water, and a substance possessing the smell of naphtha, containing much formic acid, with a little acetic acid. When no water is added to the alcohol a small quantity of formic acid only is formed, and the residuum possessed the smell of benzoine. He did not, however, detect the presence of benzoic acid.

Pyroxilic Spirit, by M. S. Leibig, (*Journ. de Pharm.* v. 32.) In distilling wood vinegar, wood spirit is obtained, which strongly resembles alcohol, but is very impure. To purify it after rectification, it is saturated with chloride of lime, which it dissolves, it is then allowed to settle. An empyreumatic oil which it contains, separates and swims on the surface. It is distilled a third time, and in order to separate the water it is rectified several times over chloride of calcium. Pure wood spirit is a colourless fluid with the penetrating smell of ether, possessing the taste of pepper. It boils at 140°. Its sp. gr. is 0·804 at 64½°. It burns with a blue dim flame. It consists of

Carbon . . .	0·5382	3 atoms.
Hydrogen . .	0·1097	5 ,,
Oxygen . . .	0·3510	1 ,,

and therefore may be considered as formed of

Ether . . .	1 atom.
Oxygen . . .	1 ,,

Formation of Ether, (*Poggendorff*, xxxi. 273.)—Mitscherlich, in carefully investigating the formation of ether, has observed that sulphuric acid, by its affinity for water, produces the compound of one volume of hydrogen gas, and one half volume of oxygen gas, forming water. It appears also that water passes over with the ether, and that the sulphuric acid has previously combined with the water. Alcohol will not be converted into ether when treated with other substances which have a greater affinity for water than dilute sulphuric acid. If a concentrated solution of the acid is heated with alcohol to the temperature of 140°, (252° F.) the point at which ether is formed, no trace of ether can be detected in the liquid which passes over. Ether is formed in the production of sulphovinic acid, by the action of sulphuric acid on alcohol. When sulphovinate of potash is mixed with lime at a temperature above 200°, (392° F.) sulphuric acid, salts, and alcohol are formed, with some oil of wine. Similar decompositions and combinations occur on the contact of numerous substances, as the conversion of a species of sugar into alcohol and carbonic acid; the oxidation of alcohol when it is converted into acetic acid; the conversion of starch into sugar, by boiling it with sulphuric acid. When combinations of ether with acids, as acetic ether, are treated with caustic potash, acetate of potash and alcohol are the products.

Creosote.—Hubschmann has simplified the process for preparing this substance, which at first promised to be of so much importance both as a medicine and antiseptic. (*Ann. de Chim.* lvii. 105.) He distils tar oil as it is afforded in the process for obtaining pyroligneous acid, in a large retort with a small portion of sand, in order to increase the number of bubbles which are formed during ebullition, and thus diminish its violence. What comes over at first, consisting of eupion, acetic acid, &c., is laid aside, but whenever a liquid begins to appear which falls drop by drop into the receiver, the latter is to be changed, and the distillation continued until the mass becomes foamy. The product of the distillation is then poured into a vessel with about double its volume of water, to which a sufficient quantity of sulphuric acid has been added to enable the fluid containing the creozote to swim on the surface. The liquid is then boiled for some minutes. After cooling, the colourless liquid below is separated, and the brown oil is rectified in a retort. The product may again be subjected to the same treatment with sulphuric acid and water. The colour is still brown, but after being separated from eupion it is pale-yellow.

In order to separate the eupion, the rectified product should be dissolved in a solution of caustic potash, according to Reichenbach's method.

The supernatant oil is separated, the ley heated, and after cooling, it is converted by sulphuric acid into a solution of sulphate of potash and creozote, which swims on the surface. The latter may be obtained colourless, by washing it in water mixed with a slight excess of solution of potash, and then distilling it. Hubschmann considers that, as an agent in medicine, its powers have been greatly overrated, and that the only use which ought to be assigned to it is its application for ameliorating the pain of carious teeth.

Picamare, [*pix amara*] (*Schweigg. Jour*. lxvii.)—Reichenbach gives this name to a substance obtained from tar-oil, which, by repeated distillation, being brought to a sp. gr. of 1·08, is mixed with caustic potash of sp. gr. 1·15, in the proportion of 1 part to 8. In the course of two days a compound of picamare and potash is formed, which may be decomposed, and the picamare obtained by acids. Creosote remains in the mother liquor. Pure picamare is colourless, greasy, with a strong smell, inflammable, and bitter tasted, boiling at 120° C, (248° Fahr.) It is insoluble in 1000 parts of water, to which it imparts a bitter taste. It dissolves in any proportion in ether, sulphuret of carbon, and petroleum, and does not combine with paraffine and eupion. It unites with chlorine, iodine, bromine, phosphorus, sulphur, and selenium, and dissolves in sulphuric and nitric acids. It crystallizes immediately with all alkalies, even with ammonia.

Paraffine (parum affinis.)—When tar from beech wood is distilled to dryness, three liquids pass over into the receiver, in the upper part a light tar-oil, in the middle an acid liquid, and at the bottom a heavy oil. The latter is to be distilled a second time, and when the matter becomes scaly, the receiver should be changed, and the heat increased until the residue becomes black and thick. In the receiver, which is filled with a yellow vapour, an oily liquid appears, in which spangles of paraffine are observed. From this liquid, which, if it does not exhibit the characters described, must be again distilled, the paraffine may be obtained by the following methods:—Mix it with from six to eight times its weight of spirit of wine, (sp. gr. ·837.) In a short space a thick liquid separates, which must be again washed with spirit of the same strength, till it is converted into colourless thin portions, then these are to be dissolved in hot absolute alcohol, and the solution allowed to cool. This process may be repeated until a snow white precipitate of paraffine is obtained. *(Pogg. Ann.)*

ANIMAL SUBSTANCES.

Structure of the Nerves and Brain, (*Pogg. Ann.* xxviii. 463.)—According to Ehrenberg the cerebral mass consists of parallel tubes expanding in a varicose manner, and converging to the base of the brain. The brain is a system of capillary vessels similar to the nerves. The nerves of sensation and the sympathetic nerve consist of soft, cerebral, medullary matter; the latter surrounded by nervous tubes. These may be termed jointed nerves (nerves of sensation?)

All other nerves consist of tendinous, cylindrical tubes, formed of a peculiar medullary matter, which may be called tubular nerves, (nerves of motion?)

The nervous medullary matter is absent in the brain and jointed nerves.

The structure is the same in man and all vertebrated animals. In the inferior vertebrated animals, the soft, cerebral matter is observed in small quantity, while the tubular substance is abundant.

In the vascular net of the cortical substance of the brain, large globules are scattered, which are proportional to the globules of the blood.

By the aid of powerful instruments, Krause has been able to observe in the cerebral and nervous substance small fibres, which partly run in a winding manner, parallel to each other, and partly cross each other obliquely in such a way that they can be traced through their crossings. The first appear especially in the longitudinal clusters in the base of the brain, the latter in the limits of the white and gray substance of the brain. These fibrils have generally a diameter of $\frac{1}{400}$ to $\frac{1}{640}$ of a line, but at intervals they swell into knots which are $\frac{1}{200}$ in thickness, and consist of an extensive, tough, transparent substance, soluble in water, and of spherical, slightly transparent, white, nervous globules, which possess a diameter of from $\frac{1}{640}$ to $\frac{1}{800}$ being roundish or oblong. In the thin fibrils the globules lie in one row, but in the thicker fibres two or more are arranged abreast without forming regular rows. In many parts of the nervous substance, as in the slices of the cerebral mass, few or no parallel fibres are detected, while globules either of a cylindrical or elliptical form may be observed. In the grey matter the globules are heaped together, and occasionally may be noticed transverse fibres, or their curved oblique courses traced. The knots of the fibrils Ehrenberg considered to be bladders. Krause, however, concludes that the fibrilli are solid cylinders and not tubes, because in the globules magnified 1000 times, he saw an outer border of the circuit, and on the cut edges of the brain and nerves which contain longitudinal and transverse fibrils, and therefore must be cut through. He never could observe light by magnifying to the highest degree, and by every possible change of illumination.

He considers water an improper medium through which to view the globules, because, as in the blood, their form is altered by that fluid, and he recommends the fresh serum of the blood and water holding in solution albumen.

Professor Ehrenberg, in answer to Krause, states that he has made observations with and without water upon the nervous substances, and by the aid of an instrument much more powerful than that employed by Krause, and has found them steady, and still adheres to the opinion that the fibrilli are tubes.

Combination of albumen with metallic oxides, albumen, and chloride of mercury, by F. Rose.—The precipitate by albumen in a solution of chloride of mercury is soluble in an excess of albumen, but insoluble in an excess of chloride of mercury. If the precipitation is produced by an excess of chloride of mercury, the solution passing through deposits by evaporation crystals of chloride of mercury, which have a yellowish colour, from some dissolved albumen, but very inconsiderable in quantity.

In ammonia the moist precipitate is soluble, but after some time the solution becomes muddy, and is increased by the application of heat.

In potash the moist precipitate dissolves easily, the solution depositing gradually black metallic mercury.

By acetic acid also the precipitate is dissolved, and is not altered by boiling. Sulphate of copper added to the solution produces a green, and chloride of iron a yellowish brown precipitate.

According to Bostock, the precipitate is a combination of the constituents of muriate of mercury with albumen, but Orfila considers it a compound of albumen and chloride of mercury, as its solution was coloured black by a free alkali. This, however, was no proof, because all organic substances which are not volatile, reduce mercury from oxide of mercury or solution of chloride of mercury, when a free alkali is present.

From the experiments of F. Rose, it appears that this precipitate is not a combination of chloride of mercury with albumen, but of albumen with the oxide of mercury. The same result took place with the serum of the blood. A solution of the red matter of the blood yielded with an excess of the chloride of mercury a red precipitate, which consisted of a combination of the colouring matter with oxide of mercury, albumen, and sulphated protoxide of copper.

An excess of a solution of sulphate of copper completely precipitates albumen of a green colour, which is dissolved by an excess of albumen. Ammonia dissolves the precipitate, forming a dark blue solution. Potash produces a violet solution. A solution of carbonate of soda dissolves it completely, occasioning a violet colour. Potash throws down the copper, but in the filtered liquid no sulphuric acid can be detected.

If the precipitate is heated and dissolved in nitric acid, no effect will be produced on the addition of sulphate of barytes. Hence, the precipitate consists of albumen and protoxide of copper. In one experiment the percentage of oxide was 1·69, and in another 1·60, affording a very small saturating power to the albumen. The serum of ox blood exhibited the same appearances. A solution of colouring matter of blood produces with sulphate of copper a flocky reddish brown precipitate, which is a compound of the red matter and protoxide of copper, containing 1·901 per cent. of oxide.

Albumen and Chloride of Iron.—By the mixture of the solutions of these substances a reddish brown precipitate is formed, which is readily soluble in an excess of ether.

The moist precipitate dissolves easily in ammonia, and potash has the same action.

Acetic acid and solution of sulphate of copper dissolve it likewise. In the heated residue of the precipitate with carbonate of soda, no trace of chlorine can be detected. In this combination the percentage of peroxide was in one trial 2·799, and in a second 2·887.

Albumen and Sulphate of Zinc.—This precipitate is white and is dissolved by an excess of either constituent. It is very soluble in acetic acid, ammonia, solutions of carbonate of soda and sulphate of copper. In the three first solutions no trace of sulphuric acid can be detected. Hence, the precipitate consists of oxide of zinc and albumen containing 2·729 per cent. of oxide.

Albumen combines with many other bases, the most of which are soluble both in an excess of albumen and of the salts of the base. *(Poggendorff's Ann.)*

Colouring matter of Blood. (N. Journal fur Chemie, iv. 314.)—Hembstadt conceives that as sulphur forms one of the constituents of the blood, and as iron exists in the colouring matter, the red colour of the blood may proceed from the presence of the sulpho-cyanate of iron. He states that the colour of the blood may be imitated by mixing albumen, water of the blood, or milk with hydro-sulphuret of cyanogen and a little chloride of iron.

Concretions.—Lassaigne found an elastic concretion in the lungs of a horse to consist of some fat and fibrine of the blood.

He analyzed a tumor from the kidney of a woman, and obtained an albuminous liquid in which cholestin was contained.

Wiggers found a concretion from the uterine portion of a woman's placenta to contain fibrine, with some fat and albumen 46·1645, phosphate of lime with traces of magnesia 43·6709, carbonate of lime 3·1646, water 7·000. (*Journ. de Chim. Medic.* viii. 551.)

Calculus from the Kidney.—This calculus was found in the kidney of a male subject, which had been brought to a dissecting room in Glasgow. The quantity procured was so minute, that the tests which I could apply were more limited than could have been wished in the case of this concretion, which appears to have contained at least traces of xanthic oxide.

Before the blow-pipe it blackens, giving out an odour of animal matter, and fuses into a white enamel, very soluble in nitric acid. When evaporated to dryness the residue has a fine orange colour, and when boiled with water, it does not appear to be dissolved, but tinges it of a hyacinth colour, which is converted into a lemon yellow by the addition of a little nitric acid. Insoluble in caustic ammonia. Not sensibly soluble in caustic potash, by which it is precipitated from the nitric acid solution, the precipitate not being re-dissolved by adding an excess of potash.

Creatine, (*Journal de Chem. Med.* viii. 548.)—Chevreul gives this name (from κρεας flesh) to a crystalline substance, which is obtained by heating with alcohol the extractive residue which remains after the evaporation of the solution of muscle. A substance remains then mixed with the extractive matter, from which it may be separated by crystallization. It exists in minute quantity in muscle. It is colourless, crystallizes like common salt, in cubes, has no taste, is neutral, insoluble in alcohol, very soluble in water and nitric acid.

BOTANY.

Botany of Wermland and Dalsland, by C. G. Myrin.—Dalsland is a small province of Sweden, on the west of Lake Wener, presenting an undulating surface, and belonging to the primitive formations. Wermland lies rather north of Lake Wener, and extends as far north as 61°, gradually narrowing to a point. Its length is 110 miles, and its greatest breadth 80, but it tapers gradually, and towards the northern extremity is only a few miles broad.

In both provinces the number of plants observed are of

Algae	125	
Musci and hepaticae .	197	
	——	322
Filices	35	
Phanerogamae . . .	521	556
		——
		878
Those peculiar to Wermland =	35	
Common	466	
	——	501
Peculiar to Dalsland .	55	
Common	466	
	——	521

The species arranged according to Wahlenberg are included in the following table of natural orders:

Compositæ . . .	49	Umbellatæ . .	15	Gentianeæ . . .	4
Gramina	47	Campanaceæ .	12	Coniferæ	4
Calamariæ . . .	43	Succullentæ . .	12	Coronariæ . . .	3
Tripetaloideæ .	25	Orchideæ . . .	10	Tricoccæ	3
Senticosæ . . .	24	Stellatæ	8	Rhoeadeæ . . .	3
Personatæ . .	24	Columniferæ .	8	Aggregatæ . . .	3
Caryophylleæ .	23	Sarmentaceæ .	6	Scabridæ	3
Holoraceæ . . .	22	Calycanthemæ	6	Aroideæ	2
Papilionaceæ .	21	Asperifoliæ . .	6	Spattiaceæ . . .	2
Verticillatæ . .	19	Inundatæ . . .	5	Ensatæ	1
Amentaceæ . .	19	Dumosæ	5	Sepiariæ	1
Bicornes	18	Luridæ	5	Trihilatæ	1
Multisiliquæ .	16	Rotaceæ	5	Vepriculæ	1
Siliquosæ . . .	16	Pomaceæ . . .	5	Najadeæ	1
Gruinales . . .	15				

The species of phenogamous plants and ferns found in these provinces which do not extend to Britain are chiefly the following:—

Scirpus nanus; Poa sudetica; Galium trifidum; Campanula cervicaria; Selinum carvifolia; Allium angulosum; Ornithogalum minimum; Convallaria bifolia; Juncus articulatus; J. nodulosus; J. supinus; J. stygius; Polygonum biforme; P. minus; Pyrola chlorantha; the P. um bellata

Cucubulus behen; Silene rupestris; Alsine rubra; Sedum anuum; Sorbus scandica; Rosa collina; Potentilla norvegica; Tormentilla recta; Anemone hepatica, A. vernalis; Geranium Bohemicum; Corydalis bulbosa; Orobus vernus; Vicia villosa; Trifolium agrarium, T. hybridum; Scorzonera humilis; Filago montana; Neotna repettis; Calla palustris; Carex chordorrhiza; C. leporina; C. heleonastes C. loliacea; C. canescens, C. livida; C. globularis; Salix limosa; Blechnum spicant; Onoclea struthioptens; Botrychium rutaceum; Lycopodium inundatum.—(*Kongl. Vet. Acad. Hand.* 1831, 171.)

Dr. Al Bunge has given a list of about 600 plants collected by him in 1831, principally between the great wall of China and Pekin, in the Petersburg Memoirs (ii. 75.) Among them we observe many new genera and species, and likewise a considerable proportion indigenous to Great Britain, as the *Papaver rhaeas; Chelidonium majus; Capsella bursa pastoris; Sisymbrium sophia; Lepidium ruderale; Raphanus rhaphanistrum; Medicago lupulina* and *sativa; Pisum sativum; Pyrus malus; Epilobium hirsutum; Daucus carota; Apium petroselinum; Pyrethrum parthenium; Cichorium intybus; Hyoscyamus niger; Solanum nigrum; Mentha piperita; Glaux maritima, &c.*

Fossil plants in the calcareous green sand of Skania.—Nilsson describes the remains of four dicotyledonous plants in this formation.:—

1. *Phyllites* (Acer? Cretaceum) folio quinquinervi? venoso.

2. *Phyllites* (Salix? Wahlbergii) fol oblong vel elliptic integerr, subundatis costati venosis, venis alternis petiolo mediocri.

3. *Phyllites* (Almis? Friesii) fol osubrotundato elliptico? subcrenato costato, venoso, venis alternis frequentioribus.

4. *Phyllites* (Comptonia? antiqua) folio sinuato venoso, in petiolum fere attenuato, lobis integerrimis Monocotyledonous.

5. *Cannophyllites septentrionalis* fol lanceolat? undato nervis frequentissimis e costa parallele exeuntibus, et angulos acutos formantibus.

6. *Cycadites Nilssoni* fronde pinnata pinnis 5-6 long lin lanceolat integerrimis marg subrevolutis? unnervibus canaliculato carinatis e petiolo basi dilatato, oblique unilateraliter exeuntibus.

Cycadites praecedentes speciei? Spad linear, elongat subcylindric squam imbric fructum superantibus ovat subrotund obtusiusculis integer convex, inferior patulis, superior adpressis, fructibus inferior, magis explicatis subrotund depressis convex obtusissimis, arcte imbricatis magnitud lentis superior, multo minor magisque globosis.

Plants in the coal formation of Skania.—Abies Sternbergii, ramulis adscendenti erectis tuberculatis: fol confert tuberculis insertis linear, acutiuscul sessil, uninervibus erecto, patentibus, vel patent, semipollicaribus ramulis paullo angustioribus.

Lycopodites phlegmariformis caule erectiusculo, fol integer, acutiusculis, erectopatentibus uninervibus (per exsiccationem) transverse lineatis semiamplexicaul, alternis, inferior remotioribus oblong lanceolat, superior imbricat oblong minoribus.

Potamophyllites? Agarethiana, fol lingulato linear nervosis, integerrimis.—*Kongl. Vet. Acad Handl.* 1831, 340.

Article IV.

Analysis of Kirwanite. By Robert D. Thomson, M. D.

This mineral, to which it is proposed to apply the name *Kirwanite*, in honour of the late distinguished Irish chemist, is found in the county of Antrim, filling amygdaloidal cavities in basalt.

The texture is fibrous; the fibres diverge from a centre, forming green brushes; opaque; about the hardness of sulphate of lime. Before the blowpipe *per se* becomes black, and partially fuses. Fuses with soda, borax, or salt of phosphorus, into a dark brown glass. Sp. gr. 2·941. The composition of the mineral is

Silica	40·50
Protoxide of iron .	23·91
Lime	19·78
Alumina	11·41
Water	4·35
	99·95

which corresponds with 4 atoms Silica
1 ,, Lime
1 ,, Alumina
1 ,, Water.

Hence, its formula is $C\,S + f\,S + Al\,S^2 + Aq$.

ARTICLE V.

Chemical Analysis of Wollastonite. By

ROBERT D. THOMSON, M. D.

THE term *Wollastonite* has been applied to a variety of minerals. Hauy distinguished the table spar or bisilicate of lime by this name. And the same title has been bestowed, it appears, on Zurlite, which is brought from the Capo de Bove, near Rome, and is described by Remondini, in the Memoirs of the Academy of Naples.

The Wollastonite of the Castle Hill, Edinburgh, turned out on analysis to be Prehnite. The other localities where table spar is said to occur, must therefore, be considered as doubtful. It would seem proper that the names by which these minerals have been recognized, should continue to be attached to them, and that the name of Wollaston should be conferred on a distinct species. "I have been induced," says Dr. Thomas Thomson, "in order to commemorate the many obligations which mineralogy owes to Dr. Wollaston, to apply the term *Wollastonite*, to a mineral which I believe to be new, and which has a very close relation to the species, which Hauy designated by that name," (*Edinb. Trans.* 1831.)

The following particulars were ascertained with the assistance of Professor Thomson:—

The mineral occurs in veins, in a green stone which is brought to Glasgow from Kilsyth, and is found abundantly on the banks of the Forth and Clyde canal.

It possesses a white colour with a slight shade of green. Texture fibrous, the fibres being arranged in tufts diverging from a centre, and thus having the appearance of imperfect crystallization. The edges are translucent, and the lustre inclines to silky. Fracture splintery, and the fragments are sharp edged. Hardness intermediate, between that of selenite and calcareous spar; sp. gr. from 2·850 to 2·8760. Before the blow-pipe it melts with some difficulty into a white enamel with froathing. With borax it fuses into a bead, yellow while hot, but becoming colourless on cooling. With salt of phosphorus in excess, it fuses into a colourless bead, leaving a skeleton of silica. With carbonate of soda, it effervesces and fuses into an opaque bead with a reddish blue colour.

25 gr. were twice analyzed, by fusion with carbonate of soda and solution in muriatic acid precipitation by the appropriate re-agents. The sum of the constitutents in one case, (consisting in both of silica, lime, magnesia, peroxide of iron, alumina and water,) was 22·050 gr., and in a second instance, 22·455 gr. It was obvious, therefore, that the deficiency was owing to the existence of an alkali as a constituent of the mineral.

10 gr. of the mineral were finely pounded, and intimately mixed in a platinum crucible with 50 gr. carbonate of barytes, prepared by precipitating the chloride of barium by carbonate of ammonia, the chloride of barium having previously had a stream of sulphuretted hydrogen passed through its solution, to separate the lead which is usually mixed with that salt as it is met with in shops.

The mixture was kept at a red heat for nearly two hours. The decomposed mass was then digested in dilute muriatic acid. The whole of it dissolved with the exception of the silica which was thrown on a filter and washed with hot water. Carbonate of ammonia, and a little caustic ammonia precipitated the remaining constituents and the barytes. The liquid from which every thing was separated except the alkali was evaporated to dryness, and cautiously ignited in a platinum capsule. What remained proved to be chloride of sodium. It weighed 1·8 = ·72 sodium, which is equivalent to ·96 soda. The constituents per cent. are,

Silica	52·744
Lime	31·684
Soda	9·600
Magnesia . . .	1·520
Peroxide of iron .	1·200
Alumina . . .	0·672
Water	2·000
	99·420

Now, we may consider this as equivalent to

26·37 atoms of silica
9· ,, lime
2·4 ,, soda
·5 ,, magnesia

or, considering a portion of the soda replaced by magnesia, we should have nearly

9 atoms silica
3 ,, lime
1 ,, soda

equivalent to 3 atoms bisilicate of lime
1 atom tersilicate of soda,

and expressed by the symbol $3\,C\,S^2 + N\,S^3$; or we may consider the magnesia replacing the lime, which would make the composition of the mineral

4 atoms bisilicate of lime
1 atom tersilicate of soda

with the formula, $4\,C\,S^2 + N\,S^3$. Whatever view we adopt, we see that the mineral differs essentially from table spar, which consists of one atom of lime united to two of silica, answering to the formula $C\,S^2$.

ARTICLE VI.

On Spirits. By ANDREW STEEL, M. D.[*]

Of all the numerous manufactures which this country possesses, and which have contributed so materially to her wealth and influence, there is scarcely one which has attracted less the attention of men of Science, or in which the progress of Chemistry has been the means of introducing so little improvement, as that of Spirits. Whilst others have been more or less perfected as the nature and properties of the materials employed or products obtained have been more accurately determined, this has remained nearly stationary.

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[*] The death of this excellent young man, in December, 1832, from disease contracted in India, deprived Science of a most promising supporter, society of an amiable member, and the Editor of an affectionate friend. In order to account for some allusions which occur in the present article, it is necessary to observe, that it constituted the first of a series of papers, which he was preparing to draw up from original investigation, when the chequered scene of life closed on him for ever.—" Lævius fit patientia quicquid corrigere est nefas."

The subject is undoubtedly a difficult one, from the little progress that has yet been made in the developement of the laws which regulate the formation and decomposition of organic substances. Whether we shall ever be able to reach this point is questionable; it can only be hoped for as the result of an accumulation of facts, ascertained by careful and persevering examination of the processes themselves.

Hence, it is to be regretted that in place of this, the ingenuity of our distillers should have been so exclusively directed to the improvement of their apparatus; and considerable as we must allow their success in this way to have been, it is highly probable that had the same expense and labour, neither of which have been spared, been directed with different views, the results would have been still more satisfactory.

The usually received explanation of the nature of the process of fermentation itself, on the changes which take place during its progress is rather the result of theoretical reasoning than actual experiment.

Hence, the very laws which regulate the manufacture of spirits from being founded on data deduced from these theories, prove uncertain in their application and inadequate to their object, and in consequence to ensure the protection of the fair trader and revenue in a case where the duty so much exceeds the cost of production, as in this article, our legislators to obviate the deficiency, have been under the necessity of imposing checks and regulations of the most restrictive kind: obliging the manufacturer to follow a certain routine, and leaving him but a very limited extent of power to attempt alteration or improvement.

The operation of these laws, therefore, however necessary in a revenue point of view, must with justice bear part of the odium of the little progress that has been made in improving this branch of our national industry.

Not that our revenue Boards have been indifferent on the subject or unaware of these legal differences, though hitherto from the want of more correct principles, the numerous attempts that have been made at improvement, have been found productive of but little real advantage.

The importance of the subject whether considered as regards the interest of the agriculturist, the manufacturer, or the revenue, appears at once from the facts, that in the United Kingdom, above twenty-three million gallons of spirits are annually produced, requiring above one and a third million quarters of grain, the value of which may be estimated at two and a half million pounds sterling, and yielding a revenue to the Crown of above five millions per annum, exclusive of the malt duty.

That processes involving such vast interests should have in this country been so much neglected, is certainly to be wondered at. By our continental neighbours the subject has been prosecuted with much assiduity. Their not being hampered by such restrictive laws, in addition to the facilities afforded in an investigation of this kind, by the immense quantity of grape juice fermented, has enabled them in some points decidedly to get the start of us. Not limited to a certain class of materials, beetroot, potatoes, even the potatoe apple and a number of other vegetable productions, are made to yield a quantity of excellent spirit sufficient to afford a fair remuneration to the distiller.

Although our present revenue laws do not allow this promiscuous employment of material, we have no doubt that if it could be shown to be advantageous, to permit the employment of others than those now sanctioned, or as regards these if any alteration could be suggested by which the processes could be shortened or rendered more productive, little difficulty would be experienced in obtaining such a modification of the laws as to give encouragement to the improvement of a manufacture of such national importance.

At present an inquiry of this kind is one of peculiar interest from the question of the propriety of the introduction of molasses as material into our Breweries and Distilleries, having been so lately the subject of a Parliamentary investigation, and the very contradictory evidence delivered to the committee of the House of Commons, is a sufficient proof, if any were wanting, how uncertain the notions of even practical men are on this subject.

Having the results of a considerable number of experiments connected with these points which we have made at different times, a knowledge of which we think will be found useful both by the manufacturer and chemist, and at all events may serve to draw the attention of others more qualified to the subject; we have been induced to arrange them as in the following papers, and shall in the present, as preliminary, confine ourselves to the composition of spirits of different specific gravities, a fact necessary to be accurately ascertained before proceeding to an examination of the processes by which they are produced.

Various tables of this kind have, indeed, been published in the continental periodicals, but besides differing from each other, and being drawn up for temperatures rendering a calculation, and that from uncertain data, necessary to reduce them to that usually employed in this country, the specific gravities are only given the length of three figures, a degree of accuracy scarcely sufficient even for practical purposes.

The very elaborate tables of Mr. Gilpin published in the transactions of the Royal Society for the year 1794, the result of four years experimenting, though highly valuable in themselves, from the inconvenient form in which they are drawn up, and the unfortunate choice of a compound in place of pure alcohol as the standard; the calculations necessary in making use of them in practice are so tedious and complicated, as to have rendered them of but very little practical utility.

From the care and attention bestowed on these experiments, the accuracy of the results can hardly be questioned; hence, any attempts at repetition, on the same extended scale at least, and probably with an inferior apparatus, would to say the least of it be quite superfluous; a very few carefully performed experiments being quite sufficient to afford data for re-calculating the whole of these experiments if necessary, and arranging them in a really useful form, though a very small part is all that will be required for our present purpose.

These experiments have merely consisted in making mixtures of alcohol and water, and deducing from the specific gravity of the compound, the composition of Mr. Gilpin's standard spirit.

Of the ultimate composition of anhydrous alcohol, the number of distinguished chemists who have made it the subject of investigation, and with results so closely agreeing leave no doubt of its being a compound of

1 Atom Olefant gas	1·75
1 Atom water	1·125
	2·875

or at least of Carbon, Hydrogen and Oxygen in these proportions.

For its preparation various processes have been recommended by different writers. Mixing it with substances having a powerful affinity for water, as the diliquescent salts, and distilling, or by placing it along with the same salts, or what is preferable, with quick lime in separate vessels under an exhausted receiver.

It is not a matter of indifference however, which of these processes are followed, as the specific gravity of the resulting alcohol will be found to differ; that obtained by abstracting the water by means of quick-lime, will in general be found heavier than that obtained by distillation from the deliquescent salts, more especially carbonate of potash. This has been accounted for by supposing the formation of a little ether during the process.

The real reason we believe to be the presence of a small variable quantity of one or more peculiar oils, of which every specimen of commercial spirit that we have had an opportunity of examining contains more or less; the origin and nature of which we shall endeavour to ascertain more particularly afterwards.

When carbonate of potash is employed, the greatest part of this oily matter is separated, while, by the other process, it is allowed to remain; hence, the reason of the difference in specific gravity; the correctness of this supposition could only be proved by ascertaining the specific gravity of the oil itself, the small quantity that we have been able to procure has rendered this impracticable, not more indeed than to allow us from its properties to decide that it was an oil.*

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* It has often been remarked that when potash or its carbonate is added to spirits, and the mixture allowed to stand for some time, it becomes yellow coloured, this, in place of being occasioned by the decomposition of the alcohol, we believe to be only a test of the presence of the above mentioned oil.

We are, therefore, inclined to give the preference to Lowitz's process, though even by it the alcohol obtained is not always uniform in its specific gravity. The variation is however but trifling.

When dry carbonate of potash is added to spirits till it is no longer dissolved, but remains dry at the bottom of the vessel, the specific gravity of the residual alcohol after distillation, which is necessary to free it from the yellow matter and a minute quantity of the carbonate of potash which it holds in solution, is uniform, varying but very little, in repeated trials we have made from ·8179 at 60°.

The mean of two experiments with peroxide of copper, performed however, with an apparatus too imperfect to give more than a mere approximation, gave as its composition:

Olefiant gas . . .	54·632	7·
Water	45·368	5·813
	100·	

Approaching very nearly 4 atoms of alcohol and 1 of water.

That this is really the true composition of the spirit obtained in this way, is still more satisfactorily proved from its specific gravity being almost identical with that of the mixture of alcohol and water made in those proportions.

The fact we think if correct will prove valuable by enabling chemists to obtain with comparatively little trouble, a highly rectified alcohol and that of uniform strength, from a want of attention to which, and employing alcohol of different strengths in their experiments, our knowledge of the properties of this important substance is still extremely limited.

It was the determination of this point that induced us to make choice of atomic proportions in the experiments, of which the following table exhibits the results.

The alcohol employed was of the specific gravity of ·79460 at 60°, it contained no trace of oil, nor did it with the nicest re-agents afford the least indication of containing carbonate

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If this yellow coloured alcohol be gently distilled to dryness, the colouring matter remains behind, combined with the potash, from which it may be separated by the addition of an acid, under the form of a fœted oil. The whole of this is not, however, abstracted by one process, but by repetition, rejecting the first portion distilled in each, we at last obtain an alcohol, which suffers no change whatever on the addition of potash.

of potash, which has been stated by M. Dubue to be always the case with alcohol prepared by its means.

The mixtures were made by weight, well shaken, and allowed to stand 24 hours before the specific gravity of the mixtures was determined.

Atoms of		Weight of		Spec. Grav. of Mixture.	Mean Spec. Grav.	Condensation.
Alcohol.	Water.	Alcohol.	Water.			
1	0	2·875	—	·79460	—	—
4	1	11·5	1·125	·81793	·80945	·00617
3	1	8·625	1·125	·82598	·81392	·01206
2	1	5·75	1·125	·83843	·82224	·01619
1	1	2·875	1.125	·86726	·84334	·02392
1	2	2·875	2·25	·90420	·87336	·03084
1	3	2·875	3·375	·92662	·89373	·03289
1	4	2·875	4·5	·94118	·90847	·03262
1	5	2·875	5·625	·95090	·91961	·03130
1	6	2·875	6·75	·95763	·92833	·02930
1	7	2·875	7·875	·96243	·93555	·02708
1	8	2·875	9·	·96597	·94111	·02486
1	9	2·875	10·125	·96871	·94593	·02278
1	10	2·875	11·25	·97092	·95002	·02090
1						

(To be continued.)

Article VII.

ANALYSES OF BOOKS.

Philosophical Transactions for 1834, Part II.

This portion of the transactions of the Royal Society contains several important papers, especially in the department of electricity. The contents are:

On some Elementary Laws of Electricity. By W. Snow Harris, F. R. S.

On a general method in Dynamics. By W. R. Hamilton, Esq.

An Investigation of the Laws which govern the motion of Steam Vessels, by P. W. Barlow, Esq.

On the generation of the Marsupial Animals. By R. Owen, Esq.

Observations on the structure and functions of tubular and cellular Polypi and of Ascidiæ. By Joseph J. Lister, Esq.

On the nervous system of the Sphynx Ligustri. By G. Newport, Esq.

Experimental Researches in Electricity, 8th Series. By M. Faraday.

On the functions of some parts of the Brain. By SIR CHARLES BELL.

On the repulsive power of Heat. By the Rev. B. POWELL.

On the equilibrium of a mass of Homogeneous Fluid at liberty. By JAMES IVORY, Esq.

Observations on Torpedo. By JOHN DAVY, M. D.

Remarks in reply to Dr. Daubeny on the air disengaged from the recent Volcano. By JOHN DAVY, M. D.

On the ova of the Ornithorynchus Paradoxus. By R. OWEN, Esq.

Observations on the motions of Shingle Beaches. By H. R. PALMER, Esq.

Analysis of the Moira Brine Spring. By A. URE, M. D.

Experiments on the Velocity of Electricity, &c. By C. WHEATSTONE, Esq.

Electricity.—Mr. Harris for the purpose of prosecuting his researches invented a new electrometer, by the medium of which he has observed two new laws. 1. A given quantity divided upon two perfectly similar conductors, was found to exert upon external bodies only a fourth part of the attractive force apparent when disposed upon one of them. 2. When divided upon three perfectly similar conductors, the force upon either is only one ninth of the force apparent when disposed upon one of them, and so on; that is, the quantity being constant, the force is as the square of the surface inversely, or the surface being constant as the square of the quantity directly. These are illustrated by the following experiment:

Three or four perfectly similar and equal conductors of a cylindrical form being well insulated, a given quantity of electricity was communicated to one of them by means of a charged jar, and the attractive force measured by the electrometer. The electrified bodies being now reduced to a neutral state, a second equal quantity was again communicated to the same conductor as before, after which it was caused to touch one of the others so as to divide the charge on both. Each conductor was observed to be equally charged; the force however after making the requisite correction for distance between the attracting bodies amounted only to one fourth of the previous force. The results are represented in the following table:

Comparative quantity.	Force in degrees.	Distance of attracting surfaces.	Force at distance of an inch.
1	30°	·1	30°
½	5—	1·25	7·8—
⅓	2+	1·28	3·27+
¼	1+	1·29	1·8+

2. The author distinguishes three elements peculiar to the conditions of electrical accumulation. 1. The comparative quantity actually accumulated. 2. The quantity not sensible to the electrometer. 3. The quantity appreciable by the electrometer.

3. It was supposed by Mr. Singer, that the diminished intensity observable in disposing a given quantity of electricity, is altogether referable to the attractive force of the atmosphere, to the influence of which the electric particles become more extensively exposed; but this hypothesis is not corroborated by the experiments of Mr. Harris

He placed a brass ball about two inches in diameter in the centre of a large receiver, and connected it with an electroscope by means of a brass rod passing right through a collar fixed in a glass plate and socket. A quantity of electricity was communicated to the ball, sufficient to cause a divergence of 40° in the electroscope. This effect was not influenced by removing fifty-nine sixtieths of the air in the receiver.

4. In reference to the transmission of electricity between conductors, it appears that when the attracting force operating between two conductors can overcome the atmospheric pressure, a discharge ensues between the nearest points of the opposed surfaces. In these points the force appears to become at length indefinitely great in respect of points more remote, so that the whole quantity accumulated is finally determined through them. Thus the precise points of contact between two spheres being found, and the spheres subsequently separated by given distances measured between these points, it may be shewn that the respective quantities requisite to produce a discharge will vary with the distances directly. The distance at which electricity can be discharged in air of a given density is an accurate measure of the comparative quantity contained in a unit of space, or of the tension (by which is to be understood the elastic force of a given quantity accumulated in a given space, and is directly as the density of the stratum,) and the attractive force discovered by the electrometer, or the intensity is directly as the square of the quantity contained in a unit of space.

5. The effect of an atmosphere varying in density and temperature in restraining electrical discharges, is as follows:

1st. The respective quantities requisite to pass a given interval, varied in a simple ratio of the density of the air. When the density was one half as great, the discharge occurred with one half the quantity accumulated, that is to say, with one fourth of the attractive force indicated by the electrometer. 2nd. The distance through which a given accumulation could discharge was found to be in an inverse simple ratio of the density of the air, the intensity or free action being constant. In air of one half the density, the discharge occurred at twice the distance, or the resistance of air to the passage of electricity is as the square of the density directly, and if as the density of the air be decreased, the distance between the points of action be increased, the electrical accumulation will still remain complete.

6. Heated air is not as is frequently stated a conductor of electricity, and heat does not facilitate electrical transmission through air in any other way than by diminishing its density. Supposing heat to be material, it is a non-conductor of electricity, because the incorporation of a conducting with a non-conducting substance is found to impair the insulating power of the latter, as in the case of air charged with free vapour, whereas in the intimate union of two non-conductors the insulating power remains perfect.

7. Sir Humphry Davy has well illustrated the effect of heat in imparing the conducting power of metals, and the same fact has been observed by Mr. Christie. Dr. Ritchie, however, has lately brought forward an objection; for, in transmitting electricity over a forked iron rod, one of the legs of which he heated to redness, he found

that the electricity passed in preference from the heated side rather than from the cool side. To make this experiment free from objection, it would be necessary to insert the heated iron rod in an exhausted receiver. Dr. Ritchie was aware of this, but conceives that the effect of a heated wire would be a species of electrical evaporation from its surface. His very ingenious paper in the philosophical transactions has certainly not attracted that attention which it deserves. The objection stated to his experiment by Mr. Harris, does not appear to affect the results which he obtained.

8. Volta observed that of two plane surfaces of equal area, that which has the greatest extension has also the greatest capacity for electricity. Mr. Harris has prosecuted this fact, and ascertained that the intensity varies in an inverse ratio of the perimeter of plates which he employed, varying in shape from a circle through a square up to a long parallelogram. The following illustrates the results:—

DIMENSIONS,—AREA = 75 SQUARE INCHES.

Length.	Breadth.	Perimeter.	Intensity.
12·5	6	37 inches.	9°
25·	3	56 ,,	6
54·5	1·4	112 ,,	3

The extent of edge has no influence on the intensity. The intensities of conductors are therefore, it appears, inversely as their perimeters, and the intensity varies in an inverse ratio of the area when the perimeters remain the same, from which, it follows that the intensity must vary inversely with those quantities jointly, or calling I, intensity, A, area, P, perimeter, we have

$$I \propto \frac{1}{AP}$$

But supposing the quantity of electricity to vary, then the intensity being as the square of the quantity, the formula is

$$I \propto \frac{x^2}{AP}$$

and the capacity of a conductor being measured by the quantity of electricity it can receive under a given intensity, there follows $x^2 \propto$ I A P, or with a constant intensity, x representing the capacity, we obtain capacity

$$\propto \sqrt{AP}$$

It appears that the intensity does not vary in an inverse ratio of the square of the surface according to the general law, except when the areas are so disposed that the whole perimeter of the various plates is as the respective surfaces.

9. The operation of electricity on distant bodies, by induction, is quite independent of atmospheric pressure, and is exactly the same in vacuo as in air, the attractive force varying as the squares of the respective distances inversely.

1*st.* The attractive force exerted between an electrified and a neutral uninsulated conductor, is not at all influenced by the form or disposition of the unopposed portions.

2*d.* The force is as the number of attracting points in operation directly, and as the squares of the respective distances inversely; hence the attractive force between two parallel plane circles being found, the force between any other two similar planes will be given.

3d. The attractive force between two unequal circular areas is no greater than that between two similar areas each equal to the lesser.

4th. The attractive force also of a mere ring and a circular area on each other, is no greater than that between two similar rings.

5th. The force between a sphere and an opposed spherical segment of the same curvature, is no greater than that of two similar segments, each equal to the given segment.

It has been much agitated whether electricity can pass through a vacuum, but the fact is, that as it is impossible to produce such absence of matter by artificial means, it seems unnecessary to dwell upon it.

The experiments of Harris go to prove that electrical divergence is completely independent of atmospheric attraction, and is therefore in accordance with the opinion with which he sets out, that electricity is a subtle material agent, essentially involved in the constitution of ordinary matter. The experiments, however, upon which such deductions can be founded, it is obvious, must be conducted with the greatest delicacy, and in such cases, absolute certainty is scarcely to be looked for.

The paper of Dr. Faraday constitutes the Eighth Series of his researches in electricity, and consists of corrected and extended views of the theory contained in his Fifth and Seventh Series. The whole paper is pregnant with important matter. It has been objected to Dr. Faraday's papers on electricity that they are difficult to understand, in consequence of the new nomenclature which he has introduced, and perhaps there is reason, in some instances, in similar complaints, for surely, it is said, when plain English words can express facts or opinions, it is improper to substitute technical expressions, either in science or literature; and a language which can muster, in alphabetical array, seventy-five thousand words, does not stand in need of unnecessary innovations. Such observations, however, do not apply in the present instance; because, the new terms are few, and obviate much circumlocution. They may, however, be attended to with propriety by those who are only entering upon discovery. In medicine, more especially, it is too obvious that technicalities have served, in many instances, to form cloaks for ignorance and quackery.

In the present series, the author enters upon the investigation of the important point whether the supply of electricity is due to metallic contact or chemical action. For the purpose of determining this point, he took a plate of zinc, about eight inches long and half an inch wide, which was cleaned and bent in the middle to a right angle. A plate of platinum, about three inches long and half an inch wide, was fastened to a platinum wire, and the latter bent to a right angle. These two pieces of metal were arranged together, but outside a vessel, and its contents, which consisted of dilute sulphuric acid, mingled with a little nitric acid. A piece of folded bibulous paper, moistened in a solution of iodide of potassium, was placed on the zinc, and was pressed upon by the ends of the platinum wire. When under these circumstances, the plates were dipped into the acid of the vessel described, there was an immediate effect at the bibulous paper, the iodide being decomposed, and iodine appearing at the *anode*, *i. e.*, against the end of the platinum wire. As long as the lower ends of the plates remained in the acid, the electric current continued, and the decomposition of the iodide proceeded. On removing the end of the wire from place to place on the paper, the effect was evidently very powerful, and on placing a piece of turmeric paper between the white paper and zinc, both papers being moistened with the solution of iodide of potassium, alkali was evolved at the *cathode*, against the zinc, in proportion to the evolution of iodine at the *anode*. Hence, the decomposition was perfectly polar, and decidedly dependent upon a current of electricity passing from the zinc through the acid to the platinum in the vessel, and back from the platinum, through the solution to the zinc at the bibulous paper. The fact of the decomposition being produced by the electrical current, was proved by the circumstance of the decomposition ceasing when the acid and its vessel were removed from the plates, and being again removed when the contact was repeated. The same position was deduced by varying the experiment, amalgamating pieces of zinc over the whole surface, and employing dilute sulphuric acid in the vessel. The same effects resulted when caustic potash was used instead of acid, and also when brine was substituted. The inferences which the author draws are, 1*st.*, That metallic contact is not necessary for the production of the voltaic current; 2*d.*, That a most extraordinary mutual relation of chemical affinities of the fluid exists which excites the current and the fluid which is decomposed by it.

The use of metallic contact in a single pair of plates appears evident from the experiments. For when an amalgamated zinc plate is dipped into dilute sulphuric acid, the force of chemical affinity exerted between the metal and the fluid is not sufficiently powerful to cause sensible action at the surfaces of contact, and occasion the decomposition of water by the oxidation of the metal, although it is sufficient to produce such a condition of the electricity as would produce a current if there was a path open for it.

Now, the presence of a piece of platinum touching both the zinc and the fluid to be decomposed opens the path required for the electricity, because only one set of opposing affinities are to be overcome; whereas, when metallic contact is not allowed, two sets of opposing affinities must be conquered. Some have considered it impossible to decompose bodies by Hare's calorimeter, or Wollaston's powerful single pair of plates, but this was owing to their considering the decomposition of water a test of the passage of an electric current. But the author observed that bodies would differ in facility of decomposition by a given electric current, according to the condition and intensity of their ordinary chemical affinities, and he has corroborated the fact by new experiments. In employing different fluids to excite the action, he procured currents of electricity varying in intensity and by consequence in their effects. Dilute sulphuric acid acting upon the zinc and platinum plates decomposed *iodide of potassium*, *protochloride of tin, chloride of silver,* but water acidulated with sulphuric acid, solution of muriatic acid, solution of *sulphate of soda,* fused *nitre,* and the fused *chloride* and *iodide of lead,* were not affected by a single pair of plates excited only by dilute sulphuric acid. All these substances were, however, readily decomposed by adding a little nitric acid to the dilute sulphuric acid. It is sufficiently obvious that the addition of the nitric acid operated by increasing the intensity or power of the current.

By the reference which is thus made of the intensity of the electric current to the intensity of the chemical action, the conclusion is drawn that by using bodies such as fused chlorides, salts, &c., which may act upon the metals with different degrees of force, effects would be obtained due to different intensities, which would serve to assist in the construction of a scale, so as to supply the means of determining relative degrees of intensity accurately in future researches. The bodies which have been examined are decomposed in the following order, the first being disunited by the current of the lowest intensity. Iodide of potassium (solution.) Chloride of silver (fused.) Protochloride of tin (fused.) Chloride of lead (fused.) Iodide of lead (fused.) Muriatic acid (solution.) Water acidulated with sulphuric acid.

Another proof that metallic contact has nothing to do with the production of electricity, and that electricity is only another mode of the exertion of chemical forces, is the production of the electric spark before the metals are brought in contact, and by the influence of pure chemical agency in an experiment where the spark is obtained by placing in contact a plate of zinc and a plate of copper, and plunging them in dilute sulphuric acid.

The principles which the author endeavours to establish in the course of his researches are, that the electricity of the voltaic pile is not dependent either in its origin or its continuance to the contact of the metals with each other. It is entirely due to chemical action, and is proportionate in its intensity to the intensity of the affinities concerned in its production, and in its quantity to the quantity of matter which has been chemically active during its evolution. The production of electricity is a case of chemical action, while electric decomposition is simply a preponderance of one set of chemical affinities over another set which are less powerful. The scource of the electricity exists in the chemical action which takes place directly between the metal and the body with which it combines, and not in the subsequent action of the substance so produced with the acid present. Thus if zinc, platinum, and muriatic acid are employed, the electricity depends upon the affinity of the zinc for the chlorine, and circulates in proportion to the number of atoms of the zinc and chlorine which unite. But for this direct action upon the metal itself, it is essential that the oxygen or other body be in the state of combination, and limited to the state of an electrolyte, that is a body which is decomposed when the electric current is transmitted through it.

Some bodies there are which are capable of exerting chemical action upon the metals which are not electrolytic; but these must be chosen from among the metals; charcoal also answers. No electric current is however induced by these means. An electrolyte is always a compound body, and can act as an electric conductor only when decomposing. Water is the most familiar electrolyte. The attraction of the zinc for the oxygen is greater in the case of water than that of the oxygen for the hydrogen, but in combining with it, it tends to throw into circulation a current of electricity in a certain direction. The sulphuric acid used in the voltaic circuit is not capable of producing any sensible portion of the electricity of the current, by its combination with the oxide formed, because it forms no part of an electrolite, nor is it in relation with any other body present in the solution which will permit of the mutual transfer of the particles, and the consequent conduction of the electricity. Now, an electrolyte conducts in consequence of the mutual action of its particles, but the elements of the water and sulphuric are destitute of this relation. This corroborates the statement of Sir H. Davy, that no electric current is induced by the combination of acids and alkalies. If the acid and base be dissolved in water, it is possible that a small portion of electricity, proceeding from chemical action, may be conducted by the water without decomposition, but the quantity will bear no proportion to the equivalents of chemical force. If a hydrogen acid be used, then a current may be induced by the chemical action of the acid on the base, for both bodies now act as electrolytes.

This view of the oxidation of the metal being the cause of the electric current, is proved by the effects of alkaline and sulphuretted solutions when used as conductors. It cannot be supposed that the alkali acts chemically as an acid to the oxide formed, because our knowledge leads to the conclusion that the ordinary metallic oxides act rather as acids to the alkalies. Ammonia as well as potash produced the same electric currents. Alkalies seem not to be influenced by the acids, in effecting electrical currents, but are superior in force and in bringing a metal into what is called the positive state. It is proved by the fact that if zinc and tin be used, or tin and lead, whatever metal is put into the alkali becomes positive, that in the acid being negative. Davy shewed that if iron and copper were plunged into dilute acid, the current passed from the iron through the fluid to the copper. In the solution of sulphuret of potash it is reversed. Two experiments in addition complete the series of proofs of the origin of electricity on the voltaic pile. A fluid amalgam of potassium containing not more than $\frac{1}{100}$ of that metal was put into pure water, and connected through the galvanometer with a plate of platinum in the same water; a current passed from the amalgam to the platinum, which must have been owing alone to the oxidation. Again, a plate of clean lead and a plate of platinum were placed in pure water, a current passed from the lead to the platinum, so intense as to decompose a solution of the iodide of potassium, when acted upon in the manner described at the beginning of the paper. This likewise appears to have been an instance of the effect of oxidation.

An important point to determine is the state of the metals and the conductor in a simple circuit, before, and at the instant when the metallic contact is completed. Dr. Faraday conceives it impossible to resist the idea that the voltaic current which we have seen is dependent upon oxidation, must be preceded by a state of tension in the fluid, and between the fluid and the zinc, the first consequence of the affinity of the zinc for the oxygen of the water. He endeavoured to investigate this by transmitting a ray of polarized light through a solution of sulphate of soda across the course of the electric current, and examined it by an analyzing plate, but though it penetrated seven inches, not the slightest trace of action on the ray could be detected, nor was the effect different when nitrate of lead was substituted. A beautiful experiment proves a state of tension acquired by the metals and the electrolyte before the electric current is produced, and before the metals are brought in contact. He took a voltaic apparatus consisting of a single pair of large plates, namely, a cylinder of amalgamated zinc and a double cylinder of copper, and placed them in a jar containing dilute sulphuric acid, so that they could at pleasure be placed in metallic communication by means of a copper wire, arranged so as to deposit the ends into two vessels of mercury connected with the two plates. As long as the plates were kept separate no action occurred; but when connected, a spark (contrary to the common idea) was elicited, and the solution decomposed. Hence, it appears that as the electricity is produced by the material action of the zinc and water, so these by being brought in contact are placed in a state of powerful tension, which, although it did not decompose the water, caused a spark to pass between the zinc and a fit discharger when the interval was small enough. The idea which Berzelius has broached that the heat and light of combustion are the consequences of the action of chemical affinity, without the production of an electric current, appears to the author to be a mere imagination.

With regard to the direction of the movement of evolved and combining bodies, it appears that if in a voltaic circuit, the activity of which is determined by the attraction of zinc for the oxygen of water, the zinc move from right to left, then any other *cation* included in the circuit being part of an electrolyte will also move in the same direction, and as the oxygen of the water by its natural affinity for the zinc, moves from left to right, so any other body of the same class with it *i. e.* any *anion* will follow the same course.

These statements of our author correspond with the general views of Davy in his Bakerian lecture.

(*To be continued.*)

ARTICLE VIII.

SCIENTIFIC INTELLIGENCE.

I.—*Melloni's Experiments on Heat.*

Royal Institution Evening Lecture, 23rd of January.

DR. FARADAY commenced the lectures of the season by describing and exhibiting the experiments which Melloni, a young Italian philosopher now resident at Paris, contrived to elucidate the nature of heat.

The great improvement which he has introduced, and which bids fair to enable us soon to develope completely the cause of the phenomena dependent on the presence of this important principle, is the adaptation of the thermo-multiplier as a delicate indicator of sensible heat. All the experiments which had been previously made on this subject were performed by means of Leslie's differential thermometer, which although comparatively, as to other instruments a delicate contrivance, is surpassed in an infinite degree by the thermo-multiplier. The multiplier consists of about 30 pairs of bars of bismuth and antimony; the elements being so extremely delicately formed that the extremities present a surface of $\frac{4}{10}$ of an inch square. These are made to communicate with the multiplier, by means of wires leading from the extreme bars. The multiplier consists of a coil of silver wire, armed with silk, and having a magnetic needle so placed in a free space within the centre of the coil, as to enable it to oscillate readily. Now, it was observed by Melloni, that when heat, even that of the hand, is applied to the pile, a powerful effect is produced upon the needle of the multiplier, which undergoes an immediate declination, and traverses an arc more or less great if the heat is constant in a constant interval. It is quite obvious, therefore, that this must be a most excellent thermoscope, and must be admirably adapted to the delicacy which is necessary in experimenting in reference to heat. Provided, then, with this apparatus, Melloni set about examining accurately the relations of heat and light, a problem which philosophers have long been endeavouring to elucidate. For this purpose, he studied permeability of heat through different bodies. Mariotte concluded, from his experiments, that the heat of a common fire does not pass through glass, or at least, in very minute quantity. Scheele went further, and decided that not a ray of heat traversed glass. Pictet, however, repeated Scheele's experiment, and obtained a contrary result. From these observations, and those of Herschel, it was inferred that heat does not pass through diaphanous substances, with the exception of atmospheric air. Prevost and Delaroche, by ingenious adaptations, proved, however, that heat is transmitted directly through glass, independent of its conducting power, and this fact has been allowed, with few exceptions, by all philosophers. But although this admission was made, the subject was involved in great obscurity, and presented an inviting field of inquiry to the ingenuity of Melloni. No examination had been instituted into the influence of the state of the surface, of the thickness of the substances through which the heat was transmitted, or of their internal structure upon permeating heat. These, however, were taken up by Melloni, and he is still engaged in the prosecution of his researches. It is easy to see how the different relative diathermal powers or capacities of bodies for transmitting heat could be determined by the apparatus of Melloni, for all that was required was to interpose the substance whose powers were to be investigated, between a steady heat and the voltaic pile, when their capacities would be indicated by the rapidity of the action upon the needle. That the heat is actually transmitted, and does not pass by conduction, is proved by the fact that the internal portions of the glass do not instantly become heated, which is demonstrated by placing a glass screen in front of the pile, nd intercepting the communication with the source of heat. The posterior surface of the glass plate would radiate the heat conducted from its interior towards the pile if the hypothesis that the heat is communicated by conduction were correct. But this does not occur, and hence, there is no alternative left but the conclusion that heat permeates bodies directly. Heat and light agree, therefore, in this property, that both possess the power of passing through bodies. It is proper that each should have such a capacity distinguished by appropriate names, until their identity be proved. Melloni terms the permeating power of heat through bodies, *diathermal* power, just as we indicate capacity of bodies to transmit light by the names, transparency, opalesence, &c. The diathermal power is subject to similar modifications. Heat, however, differs from light in this respect, that the facility with which it is transmitted by different bodies has no relation to their transparency.

Thus if we suppose the rays of a constant heat to be represented by 100, the only body which appears but slightly to diminish this when interposed as a screen is rock salt, whose diathermal capacity is 92, but the quantity of heat transmitted through a crystal of smoke-coloured quartz will be denoted by 57, and through a crystal of alum by 12 where the difference is so very great as to excite astonishment. This and similar facts have induced Melloni to conclude that heat and light are distinct; but in this opinion Dr. Faraday does not coincide.

Melloni has also examined the diathermal relation of colours, and has found that their powers are in the following order: violet 53, yellowish red 53, purple red 51, bright red 47, pale violet 45, orange red 44, clear blue 42, deep yellow 40, bright yellow 34, golden yellow 33, dark blue 33, apple green 26, mineral green 23, very deep blue 19. Hence, we see that the mineral relations of the colours to their heating power is so completely altered that the violet ray which in the spectrum possesses temperature 25 or 30 times below that of the red ray, observes here a higher temperature, but the result seems modified as occurs with light by the nature of the power employed, to illustrate the comparative experiments.

Dr. Faraday exhibited many of the experiments which Melloni has described in his papers, especially in reference to the diathermal properties of rock salt, glass, alum, with screens of which substances he had been supplied. The absorptive power of different colours, in relation to the solar spectrum was well illustrated by means of the oxy-hydrogen blowpipe. The contrivance of passing the decomposed ray through a volume of disengaged ammonia had a happy effect, the colours of the spectrum being as it were made to float in the air.

He likewise exhibited the method of polarizing light by means of tourmaline, by which fanciful figures are formed, and light transmitted or withheld by merely altering the *relative position of the screens* properly adapted.

Dr. Faraday directed the attention of the meeting to a fine bust of Mr. Fuller by Chantry, and observed that the title engraved on it was a sufficient eulogium: "John Fuller, who gave £10,000 for the encouragement of Science in the Royal Institution." A fine painting of Earl Spencer was exposed for the first time in the library, where also several ingenious models and casts, and several specimens of lithographic printing from zinc plates attracted notice.

II.—*Microscopal Objects.*

Mr. Andrew Pritchard, Pickett Street, Strand, has just published a useful little work for such persons as take an interest in examining the beauties of the minute works of nature. It contains a list of 2000 microscopic objects, and is intended to serve as a guide for selecting and labelling subjects of natural history, botany and mineralogy. Some good observations are prefixed in reference to mounting microscopical subjects, with remarks on the circulation of animals and plants.

III.—*Isinglass.*

From the experiments made by Mr. Smith in the United States, it appears that the intestines of the fish the *gadus merluccius* furnish the purest species of isinglass, (*Journ. de Pharm.* xx. 593.) not inferior to that obtained from the sturgeon. The swimming bladder of this fish is larger than that of other species of the same family. It is cut out and washed with pure water, and then dried in the sun. When partially dry it is pressed between wooden rollers as thin as paper. The long stripes of isinglass which are met with in commerce, are the intestines of the *gadus morrhua.*

IV.—*Prize of the Imperial Academy of Sciences of St. Petersburg, for* 1836.

For a considerable period it has been known that in some insects, besides the abdominal nervous system, there exists another very delicate series of nerves, situated on the dorsal portion of these animals. Something analogous has been noticed in the class of *annelides,* as in the leech, &c. This system deserves attention, because it seems to bear some resemblance to the sympathetic nerve in vertebrated animals. The Academy proposes for the subject of the prize for the ensuing year, " Researches upon the different degrees of developement of the intestinal nerves in invertebrated animals, accompanied with exact and detailed designs." They request attention to the following points :—

1. What is the developement of the intestinal nervous system in those classes of invertebrate animals where it has been observed? (especially tenthredinates, ichneumones, and some sections of hemipipterous and dipterous insects.)

2. Can a system of intestinal nerves be demonstrated in any invertebrated animals besides those in which they have been already found?

3. Can the different forms of the system of intestinal nerves be reduced to certain general types?

4. Do these general types agree with established classifications, or do the intestinal nerves follow a peculiar developement?

5. What relations subsist between the intestinal system of nerves and the rest of the nervous system, in reference to ramification and size?

6. What reasons can be alleged for or against the analogy which exists between this nervous system and the sympathetic nerve in superior animals?

The academy will grant a prize of 200 ducats to the person who shall resolve this question; but in case none of the essays sent are completely satisfactory, the author of the best of these will receive according to the extent and importance of his work, an encouraging prize of 100 or 50 ducats.

The memoirs cannot be received after the 1st of August 1836.

Meteorological Journal,

Kept at the Manse of the Parish of Abbey St. Bathan's, Berwickshire, Lat. 55° 52′ N. Long. 2° 23′ W. at the height of about 450 feet above the sea. By the Rev. John Wallace.

JANUARY.

DATE.		THERMOMETER.				HYGROMETER				BAROMETER. At 32° of Fahrenheit.				Rain in Inches. Weekly.	Prevailing Winds.	REMARKS.
1835.		IX. A.M. °	X. A.M. °	III. P.M. °	X. P.M. °	IX. AM °	X. AM °	III. PM °	X. PM °	IX. A.M.	X. A.M.	III P.M.	X. P.M.			
Th.	1	34	35	33	31	10	13	11	6	29·769	29·801	29·964	30·089	·375	N. W.	A. M. rain, P.M. calm and clear with slight frost.
Fr.	2	32	34	34	29¾	11	12	7	7	30·232	30·233	30·254	30·256		W.	Calm, clear and frosty, hoar-frost.
Sa.	3	35¼	36½	34	26	8	12	8	7	30·201	30·225	30·204	30·168		W.	Calm, clear, increasing deposition of hoar-frost.
Su.	4	23	28	32½	28	11	12	16	15	30·124	30·111	30·127	30·066		W.	Calm, clear, deposition still increasing, aurora borealis.
Mo.	5	36½	38½	39½	31½	15	14	9	15	30·123	30·130	30·149	30·179		W.	Calm, clear, hoar-frost remaining in the shade.
Tu.	6	26¼	28	31¾	25	8	4	10	8	30·116	30·097	30·017	29·964		W.	Calm, A. M. clear with strong deposition of hoar-frost, P. M. hazy, very mild.
We.	7	26	26½	33	33	7	4	13	13	29·814	29·806	29·754	29·717		W.	Calm, cloudy, little deposition of hoar-frost.
Th.	8	30½	31½	30¼	30¾	11	10	8	10	29·649	29·647	29·542	29·303	·672	W.	Calm cloudy, wind tending to shift southward, sudden gusts of wind at night.
Fr.	9	36	37½	36¾	34½	4	7	11	15	28·895	28·869	28·794	28·862		W.	A. M. rain, P. M. clear, a brisk gale with sudden gusts.
Sa.	10	32	32	35	33½	10	9	11	16	29·092	29·092	29·145	29·263		W.	Partially clear with thin white clouds, frosty, evening cloudy and calm, lunar halo.
Su.	11	29¼	30½	32	30½	11	18	20	7	29·390	29·400	29·412	29·449		E.	A. M. partially clear, P. M. cloudy, sleet in the evening, calm
Mo.	12	32½	33	34½	35½	7	5	7	7	29·361	29·346	29·267	29·226		S. E.	Calm, A. M. snow, P. M. foggy with rain.
Tu.	13	35	37	37¾	35	8	5	13	10	29·114	29·093	29·000	28·909		S.	Calm, fair, partially clear, cirri and cirrostratus, lunar halo, night frosty.
Full M. We.	14	38¾	40¼	43	35½	3	4	13	10	28·851	28·863	28·841	28·889		S. W.	Calm, A.M. cloudy with tendency to fog, at 2 P.M. cleared, slight rain, even-
Th.	15	39½	39¾	38	35¾	17	21	12	16	28·806	28·813	28·831	28·828	Drifted Snow.	S. W.	Brisk wind, A.M. partially clear, at 3 P.M. overcast, lunar halo [ing frosty.
Fr.	16	33	34	32¾	31¾	6	5	5	9	28·470	28·465	28·470	28·710		W. of N.	Heavy snow with high wind, evening fair, a thin cloud overspreading the sky.
Sa.	17	30½	27½	23	19½	10	7	6	10	29·023	29·048	29·152	29·280		W. of N.	Clear, calm, intense frost.
Su.	18	25¼	27	31	25½	3	5	16	20	29·191	29·184	29·150	29·007		S. W.	A. M. clear, light brisk wind, P. M. cloudy.
Mo.	19	32	32½	33	27½	11	10	9	12	28·656	28·664	28·758	29·213		W. of N.	A. M. cloudy with brisk wind, P. M. stormy wind with snow.
Tu.	20	25¾	28	28¼	23	10	12	15	12	29·607	29·640	29·729	29·816		W. of N.	Clear, A. M. brisk wind, P. M. calm, intense frost.
We.	21	24½	28	35¼	35	7	6	9	5	29·672	29·647	29·452	29·473		S. W.	Partially clear with soft clouds, sudden gusts of wind, evening calm.
Th.	22	36¾	38	39½	37	11	8	7	6	29·624	29·621	29·568	29·658	.000	W.	Alternately clear and overcast, calm interrupted by sudden gusts, evening calm
Fr.	23	41½	42	43½	42½	10	9	12	11	29·624	29·588	29·499	29·262		W.	Soft clouds, boisterous gusty wind, cirrostratus (cymoid arrangement)
Sa.	24	41	41½	42	43½	15	16	17	15	29·276	29·326	29·415	29·381		W.	Cirrostratus, soft clouds below, in the evening boisterous gusty wind.
Su.	25	44½	45¾	46	48½	14	17	18	11	29·416	29·469	29·509	29·505		W.	Fine, occasionally clear, cirrostratus with soft clouds floating below.
Mo.	26	46½	47½	47¼	47	12	13	17	12	29·525	29·556	29·538	29·637		W.	Sky overspread with cirrostratus, a brisk gale.
Tu.	27	46½	48	48½	39½	13	16	18	3	29·661	29·718	29·679	29·705		W.	Brisk wind interrupted by calms, A. M. cloudy, P. M. partially clear, fine.
NewM. We.	28	43	44¾	45	42½	7	8	7	2	29·585	29·576	29·507	29·448		S. W.	Occasionally a brisk wind, A.M. overcast, P.M. lowering and tending to rain.
Th.	29	43½	46½	49	45½	5	15	18	4	29·397	29·386	22·367	29·407	·030	S. W.	Fine, wind gentle but occasionally sudden gusts, sky diversified with cirri, cirro-
Fr.	30	42½	44	44½	40¼	0	4	11	12	29·465	29·485	29·444	29·413		S. W.	Heavy clouds chiefly in the south, A.M. some slight showers, deposition, [cumuli
Sa.	31	35¾	37½	42¼	40¼	2	4	9	4	29·369	29·369	29·375	29·437		S. W.	Heavy clouds with haziness, a slight shower about 1 P.M.
Means.		34⅚	36⅐	37 3/10	34⅓	9	10	11⅔	10	29·455	29·460	29·449	29·468	1·077		Means for the Month. { Thermometer 35⅓° Hygrometer 10° Barometer 29·464 in. } Mean point of deposition for January. } 27½° Fahr. a cubic inch of air containing ·001162 grains.

RECORDS

OF

GENERAL SCIENCE.

APRIL, 1835.

ARTICLE I.

Biographical Account of M. Desfontaines. By AUG-PYR DE CANDOLLE. (*Abridged from the Ann. des Scien. Naturelles, March* 1834.)

RENE LOUICHE DESFONTAINES was born at Tremblay, in the department Ille-et-Vilaine, in Brittany, a town distinguished as being the birth-place of the anatomist Bertin. His birth-day it is impossible to ascertain, as the registers of Tremblay were destroyed during the revolution. He was himself of opinion, that he first saw the light towards the end of 1751, or beginning of 1752. His father, though poor, exerted himself for the purpose of giving him as good an education as possible, and sent him to school in his native town, where he learned a little Latin. The master also endeavoured to form his morals, but treated him in the harshest manner, reprimanding and punishing him for the slightest faults, and grating his ears with the discouraging cry that he was good for nothing. One day he was threatened with severe punishment for having taken some apples from a garden, and in order to escape from his master, made his escape by a window and fled to his father's house. What was the embarrassment then of his family? What shall we do, they exclaimed, with this refractory boy who resists all chastisement and is fit for nothing? His father, persuaded by the opinion of the master, and believing that his son was not capable of making any progress in his studies, determined to make him a cabin boy. What the causes were which prevented him from following up this project are unknown, but it is probable that Science is indebted to his maternal interposition for one of her most distinguished supporters. It was determined, however, that another opportunity should be afforded him of acquiring knowledge, and the little apple stealer was sent to the College of Rennes.

The young scholar was at first impressed with the idea which had been so often repeated to him by his first master, of his being destitute of intellectual capacity, that he could scarce persuade himself of the contrary. He distinguished himself, however, in some of his first tasks; received praise for his success; had new zeal instilled into his mind, and at the end of the year carried off several prizes.

In communicating the good news to his father, he requested him to inform his first master of his success, and to remind him of his prediction that he had no capacity for any thing. He continued this innocent spirit of revenge at each new victory, and it is remarkable, that he did not cease to send similar communications until he was elected a Member of the Academy of Sciences. Those who were acquainted with Desfontaines could scarcely recognize in this anecdote of his youth, that continual modesty which so highly characterized him.

In consequence of his success at the College of Rennes, Desfontaines was sent to Paris to prosecute the study of medicine. He soon attached himself, in preference, to botany, and it was in consequence of his devotion to this study that the period of his graduation was retarded till 1782, in his 30th year. In the course of his medical studies he became intimate with Lemonnier, first physician to the king, and professor of botany to the Jardin des Plantes. Lemonnier, although not holding a place among the first ranks in Science, greatly contributed to its progress in France, by the influence which his situation enabled him to exercise with the powerful persons in the state, and the employment which he gave to promising naturalists. Commerson, Michaux, Labillardiere, and Desfontaines, were indebted for a portion of their success to his patronage. Alas! at the same time, the two last have terminated their mortal career, and history alone remains to bear witness of their labours.*

Desfontaines became the favourite and intimate friend of Lemonnier. Their simple and excellent characters, their devotion to science and the investigation of truth, established between them a powerful friendship, notwithstanding the difference of their ages. It was a similar mildness and amiableness of character which united in the bonds of friendship Desfontaines with Malesherbes, Duhamel, Denainvilliers, Fougeroux, and others. Desfontaines was also encouraged by M. Antoine Laurent de Jussieu, who was some years older than himself, and who had succeeded his uncle Bernard in the professorship of the Jardin du Roi. In 1783 he was made a Member of the Academy of Sciences. This title, which is so justly honourable, was deserved by his Memoirs on *Tithonia* and *Ailantus*, and upon the Irritability of the Sexual Organs. Determined not to remain idle, he procured the necessary funds for accomplishing a botanical journey, and encouraged by his countryman M. De Kercy, consul at Algiers, he determined to investigate the coast of Barbary, from the frontiers of Tripoli to those of Morocco, viz: the territories of Algiers and Tunis. These countries, although so near Europe, had been little visited, and had not been examined in a botanical point of view, except cursorily, by Dr. Shaw. Desfontaines' plan was approved of by the Academy, and on the 16th August 1783, he departed from Marseilles for Tunis.

He remained two years in these countries; visited them in their whole extent, from the sea to the summits of Mount Atlas, and even examined the narrow strip of land which lies to the south of this ridge, and between it and the desert of Sahara. His examination of these governments was facilitated by the protection of the French consul, and by the kindness with which he inspired the Deys. He had permission to visit the whole country, under the care of an armed Turk. Although he felt the advantage of this protection, he was in constant uneasiness lest the slightest insult offered by a Moor should be resented by his guard, whose brutality inspired him with horror. Very different was the character of the ignorant and barbarous princes of these kingdoms, who administered justice to their subjects in an equitable though rude manner.

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* Jacq Jul Hauton de Labillardiere, was born at Alençon, in 1755, and died at Paris, 8th January 1834, fifty-three days after his intimate friend Desfontaines. He travelled in Syria under the patronge of Lemonnier, and accompanied Entrecasteaux in his search for La Perouse. He had published five portions of his work on the Plants of Syria; a Voyage round the World; two volumes on the Plants of New Holland, and New Caledonia, besides some Memoirs.

During the two years of his residence in Barbary, Desfontaines laboured without ceasing. Strong and vigorous in his constitution, sober in his habits, active in investigating every subject which came under his notice, he studied ardently the botany of this country, and although half a century has elapsed since he left it, scarce a single plant has been discovered which had escaped his searching eye.

He turned his attention also to the study of animals. His fine collection of insects, deposited in the Museum of Natural History, furnished Fabricius and Latreille with several new species; and in 1787, he published a memoir describing several new species of birds which he found on the coast of Barbary. He studied also antiquities, and wrote several papers on ancient geography and ancient monuments. His Memoirs on the *Lotos* of Lybia, which supported the Lotophagi; that upon the acorns of Atlas, and one on the economical uses of dates, are proofs of his classical knowledge, and of the critical acumen with which he exercised it.

During his residence in Barbary, he formed a friendship with two botanists who visited that country with similar views to his own, which death alone terminated. These were M. M. Martin Vahl, professor of botany at Copenhagen, who has acquired great celebrity as an accurate botanist, and M. Poiret, who has published on Barbary, and reserved the account of some of his labours for the *Encyclopedie Methodique*. Connexions thus formed amid toil and danger, are much more indelible than friendships contracted amid the haunts of civilization. De Candolle makes this remark, from having often heard these old men relate with energy and pleasure the recollections of this active period of their lives.

On his return to Paris in 1785, Desfontaines found Lemonnier as friendly as ever, who at this time had almost engaged him in the unfortunate expedition of La Perouse; when illness prevented the intended project from being carried into effect. His protector then used his influence to have him appointed his successor, with the intention himself of resigning the situation which he held of Professor of Botany in the Jardin du Roi. This establishment was then under the direction of Buffon, who joined to his superior talents an overbearing manner, as is well known. He possessed *ex officio* the patronage of the professorships, and M. Lemonnier was afraid if he resigned, that a stranger would be appointed in his place. He represented the matter to Buffon, but although they were on intimate terms, no answer could be obtained except, "*Let M. Lemonnier give in his resignation and I shall exercise the powers of my office.*"

After hesitating for a considerable time, Lemonnier, however, thought he could understand the intention of Buffon, and resigned his situation without receiving any assurance from Buffon. For two days no answer was received from Buffon; but at the expiration of that time he nominated Desfontaines, giving him to understand that he did so, not for the sake of his patron but from his own free will. Thus, in 1786, Desfontaines found himself in a situation exactly suited to his taste. From this period he continued to receive new honours from the learned and from government; being one of the first named for the formation of the institute; elected by his associates to the chair of the Academy of Sciences, and Administrator to the Museum. He was appointed a Knight of the Legion of Honour, and nominated professor of Botany to the Faculty of Sciences of Paris.

The cares and duties in which he was thus engaged prevented him from drawing up the result of his labours in Barbary. Louis XVI, who had taken a great interest in this expedition from the account which his physician had given him, expressed a desire to peruse his manuscripts, and Lemonnier requested his friend to entrust his journals to him, in order that the king might read them.

These journals were unfortunately mis-laid, and as he possessed no regular copy of them, all this portion of his travels which did not consist of collections was completely lost. A few fragments retained by him, containing an imperfect account of the first part of his travels, were published by Lalande in 1784, in the *Journal des Savans.* This accident discouraged Desfontaines, and it was not till near the close of his career, and when the expedition to Algiers attracted attention to that country, that he yielded to the request of Walkenaer to admit of the publication of his manuscripts.

These fragments appeared in 1830, in the *Nouvelles Annales des Voyages* (vol. xvi, xvii.) but their author took no part in the publication, and often regretted that a publication of his should have been presented to the public, written in such a careless style and so disfigured with typographical errors.

Desfontaines being thus prevented from writing a historical account of his travels, devoted his time entirely to botany; bestowing much pains on the nomenclature of the plants of the garden and on his botanical course. In the latter, he developed the principles of vegetable physiology.

His manner was simple and clear, without any pretension, and till the last his lectures were flocked to. Extracts from these have been published in the first volume of the *Decade Philosophique*, and re-printed in the *Annales d' Usteri.* At this period of his life, being occupied with the study of the plants of Barbary, he presented to the Academy several descriptive memoirs which were published either in his Memoirs, in the Journal of Fourcroy, or in the *Actes de la Societe d' histoire Naturelle.*

During the bloody period of the revolution, Desfontaines remained shut up in the Jardin des plantes, engaged with the description of his herbarium, visiting such men of science as were cruelly put in prison, and encouraging those who required it. At his eminent peril he visited M. Ramond while in confinement. M. Lheritier being basely imprisoned and threatened with death, Desfontaines with his friend Thonin exerted himself to procure his pardon. They obtained a suspension of the sentence under the pretext that Lheritier was about to publish the collections of M. Dombey, and thus saved his life. Such conduct at that eventful period, must be characterized as a proof of the strongest friendship and of great courage, and is the more praiseworthy when the natural timidity of Desfontaines is taken into consideration; a timidity, however, which arose from an excess of modesty and distrust in himself.

On the accession of the calm which succeeded the storms of the revolution, Desfontaines appeared at the opening of the Institute with a work of the first description. His residence in Barbary had given him an opportunity of seeing much of the date tree, and his attention had thus been called to the study of the palm tribe. He had written on this subject some notes to M. Daubenton, who had made use of them in his memoir upon the organization of wood, and had presented a paper upon the subject to the Academy in 1790.

New reflections, and the comparison of a number of trees had extended his ideas, and enabled him to comprehend the intimate relation which exists between the structure of the trunk and that of the organs of the seed, upon which the basis of the natural classification was placed. In 1796, he presented a memoir upon the organization of monocotyledonous plants, which was received with the greatest praise by botanists, and placed Desfontaines in the highest rank of science. This memoir showed the great differences which exist in the structure and the mode of increase of the two great classes of Phanerogamous vegetables of which, one has the conical trunk increasing by the addition of new layers on the exterior of the ligneous matter, and the other the cylindrical trunk deprived of true bark, and increasing by fibres, of which the youngest are on the centre and the oldest on the sides. This memoir confirmed their division by characters of the first order, opened a new field to anatomists and classifiers, and although a period of forty years has elapsed, still continues to be the basis of the principal botanical works, the key of the natural method of vegetable *organography*. The author, astonished at his own triumph, appears to have considered that he had produced too great a revolution in the science, and left to others the developement of the consequences of his discovery, a fact which proves that with superior talents there must be united a certain firmness of character, in order to produce the proper consequences from a discovery.

From the period of his return from Barbary, Desfontaines was constantly employed in studying, describing, and drawing the plants which he had collected; and in 1798, he began to publish the result of his labours, under the name of *Flore Atlantique*. This work created a new era in botany, and has continued to be ranked among the most talented and classical works. It was when he was finishing this work that De Candolle became acquainted with him. Desfontaines permitted him to work with him, furnished him with the means for extending his knowledge, guided him by his advice in the method of observing the characters of plants, and treated him with the tender feelings of a father. Most of those who have obtained a scientific name in France, during the present century, can boast of a similar intimacy.

M. M. De Mirbel, and Adr. de Jussieu have expressed their gratitude in their eulogium upon him. When he had completed this great work he directed his strenuous attention to the garden, in reference to its management, and the nomenclature of the plants, and even in his old age he was to be seen carrying books, and his herbarium, for the purpose of correcting errors which had been committed during the sowing and transplanting of the plants. Neither the heat of the sun nor the inclemency of the season repressed his zeal in the discharge of his duty. He published three editions of a catalogue in 1804, 1815, and 1829.

The establishment of the *Annales des Museum*, afforded him an opportunity of describing the new plants which flowered in the garden. From 1802 to 1807 he wrote those notices in this work which have contributed so much to Science, and in 1807 and 1808, he published the beautiful plates of Aubriet, who had accompanied Tournefort, representing the plants of the east. This work testified the great esteem which Desfontaines entertained for the memory of Tournefort, and served to remove a number of misconceptions which botanists had fallen into with regard to the discoveries of this traveller.

During two or three years, in conjunction with De Candolle, he published a portion of a work containing abridged descriptions of plants cultivated in the Jardin des Plantes, but the labour was so great that the intention of completing it was given up. In 1809, he published his *Histoire des Arbres et Arbrisseaux*, containing an account of those trees and shrubs which may be cultivated in France. Its tendency was practical, and he was assisted in it by M. Deleuze. After the completion of these works Desfontaines began to feel a degree of *ennui*, for he had never possessed any taste for the world. During the revolution he was in the habit of repairing every evening to the Society of his friend M. Thonin, with whom he spent many agreeable hours, in company with the painter Van Spaendonck, and the geologist Faugas de St. Fond. His sister also occasionally visited him, when she was able to leave her native Brittany. In these circumstances, having met with a young woman, without fortune it is true, but of an open and agreeable character, he married her at the age of 63 years. This union commenced under happy auspices, and his letters at that period prove the degree of his happiness. He became the father of a daughter, for whom he entertained the greatest affection, which was the more felt in consequence of his being obliged to separate from his wife, by reason of a disease induced by a weak and delicate constitution. He now occupied his time with the examination of the herbaria of the museum, and from 1815 to 1822, enriched Science with a description of seventeen new genera of plants, in the Memoirs of the Museum. These genera are *Pogostemon*, *Chardinia*, *Ricinocarpos*, *Gymnarhena*, *Ancylanthos*, *Heterodendron*, *Mezoneuron*, *Heterostemon*, *Ledocarpon*, *Micrantha*, *Dipophractum*, *Stylobasium*, *Chamaelancium*, *Polyphagmos*, *Asteranthos*, *Gyrostemon*, *Cordylocarpon*. He published also about the same time new observations upon some known genera, as *Leucas*, *Amaiona*. He continued his zeal in making the reports with which he was entrusted by the Academy of Sciences, till between his 70th and 80th year, at an age when most men are anxious for retirement. But his senses gradually began to fail him; his sight especially, which was at one time so acute, became weaker, and in his 80th year he was threatened with total blindness. Yet, on the 10th October 1831, while in this state, he wrote a letter to De Candolle, describing an observation which he had made on the fecundation of plants, which, although not new, is not without interest.

It was represented to him that a chance existed of recovering his sight by an operation for cataract. Sometimes he felt inclined to believe this, but at other times he remembered what had been said to his colleague M. Lamarck, on a similar situation, and he derided his own credulity. Still he preserved the cheerfulness of his disposition and the benevolence of his heart; amused himself with his plants, and was delighted when he could recognize any of them by the touch. He also drew up notes for the colonization of Algiers, a point upon which he had been consulted by government.

One thought alone distressed him in the prospect of death, the circumstance of leaving his young daughter without a protector. Fortunately his nephew, to whom he had acted as a father, and who is a distinguished road and bridge engineer, had imbibed a tender regard for his cousin; and Desfontaines had the pleasure of uniting on his death-bed, the two individuals whom he most loved. Government provided for his wife. Thus assured of the happiness of his dearest friends, he met death amid suffering it is true, but with a serenity and calmness which could not be surpassed. The benevolence of his character, seemed on this occasion, to increase, and "I have learned," says Jussieu, "from his death-bed scene to love him still more." He recited classical recollections, adapted to his situation, testified his love for those friends who were present by tender remarks, sent kind remembrances to those who were absent, and at last, expired on the 16th of November, 1833, aged 81 years. His situation has been supplied by M. Adolphe Brongniart, a young botanist of the highest promise. His herbarium of Barbary, he gave to the Museum, and his general one has been obtained by Webb, a botanist, who will undoubtedly make a good use of it.

M. De Candolle, gives a list of Desfontaines publications. They amount to about 70, including memoirs and volumes. M. De Candolle characterizes Desfontaines as being one of the most excellent men that could be met with, as well as one of the most distinguished philosophers of his age.

ARTICLE II.

An Abstract of some researches on the Repulsion produced between Bodies by the action of Heat, with additional observations. By the Reverend BADEN POWELL, M.A., F.R.S., Savilian Professor of Geometry, Oxford.

THE curious point to which my attention has been directed, is one of those which too generally fail in securing the attention of philosophers, from the circumstance that they belong to a class of phenomena hardly coming within the specific range of any one of the great divisions of Science; or rather, belonging equally to several, are but little considered in any. In the "Records of General Science," however, some account of them may perhaps find a place.

At the meeting of the British Association at Edinburgh, I gave a short statement of the experiments which I had made: an account of them was also read before the Royal Society, and is now printed in the Philosophical Transactions for 1834. But a brief outline of their nature and object may not be unacceptable to some readers, especially as it will be essential to render intelligible the further observations I wish to add.

The expansion of bodies by heat seems to imply a mutual repulsion of their particles; and it is a question naturally suggested, whether such a power of repulsion may not generally belong to heat, or be excited by it between particles or masses of matter at sensible as well as insensible distances. But, however obvious the suggestion of such an inquiry, it is of a nature not easy to be pursued or decided.

The subject has been partially investigated by Sig. Libri, and by M. M. Fresnel and Saigey; but their researches do not appear to have been regarded as decisive, and have ever been viewed with considerable doubt; and they are certainly dependant upon experiments of the most extremely delicate and difficult kind, and those of Fresnel confessedly left in an incomplete state.

Recently, the inquiry has been revived by Professor Forbes of Edinburgh, who has referred to the same principle to account for the singular phenomena of certain vibrations of heated metallic bars, first noticed by Mr. Trevelyan, and since fully investigated by himself in a paper in the *Edinb. Trans.* vol. xii.

In a different form the subject had occupied my attention before I was acquainted with Professor Forbes's investigations; but, on reading his paper, a new interest attached to the inquiry, and in pursuing it, I conceive I have obtained some results which appear decisive on a question at once of importance in the analogies of physical action, and which has hitherto been regarded as at least involved in considerable uncertainty.

The method I pursued was that of forming Newton's rings, between lenses, and applying heat, which would afford a simple mode of deciding the question, if there be any separation of the glasses by repulsion, since it would be rendered visible by the *contraction of the rings*. As to the error which might arise from the *warping* of the upper glass by the heat, it will be evident, on a little consideration, that heat applied outside of either glass will tend, by the change of figure, in every case, in the first instance, to *diminish* the angle of contact: that is, if no other cause interfere, to make the rings *enlarge* without altering the central tint, until the curvature become equal to that of the convex surface.

I invariably found, however, that *from the first moment the rings regularly contract, and the central tint descends in the scale till the whole vanishes*. There are, however, several precautions necessary to be attended to. If the glasses be more than very slightly convex, the portion of surface throughout, which they approach sufficiently near for the repulsion to act, is very small. This may render the total effect far too weak to overcome the weight of the upper glass, or even its inertia, though placed vertically. With surfaces of such curvature as to give the first bright ring a diameter of about 0·3 inch, on placing a red hot poker a little above the glasses the effect never failed to be produced. Upon the whole, the experiments, though simple in principle, certainly require some care; but with all precautions, and after the most careful consideration of all causes which can have tended to produce or affect the result, it appears to me that the separation of the glasses through the extremely small, but finite and known spaces, whose changes are indicated by the degradation of the tints, can only be due to *the real action of a repulsive power*, *produced or excited between the surfaces of the glasses by the action of heat*.

There are many questions relating to the nature and properties of this repulsive power, which are immediately suggested, and some of which appear capable of solution by variations of the same method.

The *distance* at which the repulsive power can act is shown, by these experiments, to extend beyond that at which the most extreme visible order of Newton's tints is formed. But I have also repeated the experiment successfully with the colours formed under the base of a prism placed upon a lens of very small convexity; and according to the analysis of these colours given by Sir J. Herschel, (on Light, 641,) the distance is here about the 1100th of an inch.

Beyond these very small distances other methods must be resorted to. But the certainty of the result within these limits perhaps confirms its probability at greater distances, as inferred by Fresnel and Saigey.

I tried several experiments on the effects of different sorts of surfaces, from which I conceive, though we may infer that *cæteris paribus*, the better radiating power of the surface increases the effect; yet there are other circumstances which affect the result more powerfully, and these seem to be, in general, *whatever may tend to the more rapid communication of heat.*

This is still more conspicuous when the rings are formed in a thin plate of *water* between the lenses. The effect is here even greater than in air, and we may presume, independent of *radiation.*

There are several subordinate circumstances attending these results which are deserving of notice. When the lenses are in close contact, there is, in all cases, a considerable attraction opposed to the repulsive power. If the central black be formed, it requires a very considerable intensity of heat to overcome the attraction, which at that minute distance is extremely powerful.

When the heat is removed the colours return, and the rings are gradually restored to the same character as they had at first. This is more remarkable when simple plates of glass are employed as before described. When the heat has restored the bent glass to a plane figure, on its removal the rings return, and consequently, the glass is again bent without any fresh pressure, though the force originally applied to produce the curvature was very considerable; this is probably owing, in a great measure, to atmospheric pressure. In this case, however, the colours will only return up to a certain point, generally not higher than the beginning of the first order.

When two glasses are pressed together there is a repulsion to be overcome, evinced by the force which it is necessary to apply, and in general, it is evident, that if a plate resting on another be bent by pressure, as in these experiments, the influence of heat in restoring it to a plane form will be opposed both by the attraction at the centre, which tends to prevent that part from being raised, and by the repulsion towards the exterior parts, which tends to prevent them from being depressed. When the curvature begins to change, therefore, there is somewhere between them a neutral or nodal point whose position does not change; this point may be very near, or even in the centre, when the attraction is very strong there. A remarkable instance of this occurs when the first black of the scale is formed between glass plates, and heat carefully applied exactly over the central point of the black space; in this case, when the black space is a ¼ inch or more in diameter, I have often continued the application of the strongest heat for a great length of time before any separation could be effected, when at length it has taken place with a sudden force and an audible click. Sometimes the black spot has continued unaltered until the glasses have cracked, when the fragments have still continued to adhere powerfully: meanwhile the outer rings have continued gradually *enlarging*.

In the foregoing statement, I have observed, that in using plane glasses, it was necessary to allow for the effect of *warping*. But there are certain considerations which show that that precaution is unnecessary. For, acccording to the beautiful experiments of Sir D. Brewster on the progress of heat through glass, as evinced by its action on polarized light, it appears distinctly, that the change of structure (if I may so speak) in the molecules of the glass is produced *at the same instant*, on *both* sides of the plate: so that the effect of *warping* cannot take place. This is rendered evident to the eye, by the symmetrical arrangement of the luminous bands, from the first moment of the application of heat, on each side of the dark *central* band, which occupies the neutral line along the middle of the thickness of the glass.

When two plates of glass are laid upon one another there is a certain resistance or repulsion which may be overcome by pressure. We can press them together till attraction takes place. On removing the pressure they remain adhering. If we press them more they are brought closer, and produce the colours of thin plates. We may thus produce successively any given tint, and on removing the pressure that tint will remain, or the glasses continue in the same position to which they have been brought.

This seems to show that the attraction and repulsion are in exact equilibrio at all distances, (within this range,) and this may hold good with any *law*, provided the law be the *same* for attraction as for repulsion.

On the application of heat a greater intensity of repulsion is excited; if we could ascertain the law of its increase with the distance and increase of temperature, we might thence infer the law both of attraction and repulsion between the *surfaces;* and thence, (if the expression be integrable,) that between the *molecules* of the substances.

All this, as just observed, takes place only within a certain range of interval. When the central black is formed, we seem to have arrived at a limit where attraction prevails; and where the application, even of great heat, will not easily overcome it.

The close contact of a glass and liquid in capillary attraction appears to be within this limit; for here, in several cases referred to in my paper, it appears that no application of heat can overcome the attraction.

With respect to one of those experiments, viz: that of Sig. Libri, which I had stated I could not succeed in repeating, I have since been informed that the experiment *will* succeed, provided the heat applied to the wire be that of a flame urged by a blowpipe. This, at any rate, proves the great intensity of the attraction, which requires so extremely high a degree of heat to overcome it.

Oxford, Feb. 17, 1835.

ARTICLE III.

On Spirits. By ANDREW STEEL, M. D.

(Continued from p. 228.*)*

THE greatest condensation takes place in the mixture of 1 atom of alcohol, and three of water: experiments made with a view of determining this point with more minuteness, seem rather to indicate it as slightly above this.

Atoms of		Weight of		Spec. Grav. of Mixture.	Mean Spec. Grav.	Condensation.
Alcohol.	Water.	Alcohol.	Water.			
1	2·9	2·875	3·242	·92446	·81974	·03272
1	3·	2·875	3·375	·92663	·89373	·03290
1	3·1	2·875	3·513	·92877	·89581	·03296
1	3·25	2·875	3·659	·93095	·89815	·03280

or between 3 atoms and 3·1.

It is very difficult to make experiments of this nature with absolute accuracy : allowing a very small error to have been committed, it would bring it exactly to 3; to which, however, the experiments approach so nearly, as we think to warrant the conclusion, that the atomic proportion is really the point at which the greatest condensation takes place. So that, we have, at least, two definite compounds of alcohol and water, possessing distinct properties.

The first is a compound of

4 atoms alcohol . . .	11·5
1 ,, water	1·125
	12·625

and the second of

1 atom alcohol	2·875
3 ,, water	3·375
	6·250 *

From the above, with the assistance of Mr. Gilpin's table, we have computed the following, exhibiting the

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* The condensation or diminution in volume which takes place, almost without exception, on mixing substances of different specific gravities with each other, has been usually explained by writers on the subject, as the result of a powerful chemical affinity between them.

If we admit the ultimate atoms of all bodies to be spherical, by far, certainly, the most plausible doctrine that has been advanced, and in favour of which, indeed this very phenomenon of condensation, is perhaps, the most decisive proof that can be adduced, there is no need of any affinity for its explanation.

The amount of the diminution in volume, depends on the specific gravity, or more correctly, on the difference in size of the ultimate atoms of the substances, and is in fact, the mere mechanical effect that must be produced by mixing together spherical atoms of different bulks, and is well illustrated by the following simple but very striking experiment :

Lead drops of different sizes (Nos. 4, and 10,) were taken as the representatives of two substances of unequal sized atoms.

Into a graduated glass tube, 50 measures of No. 10, and 50 measures of No. 4, were introduced. Their bulk in this state was of course, exactly 100 measures, on being well shaken so as to mix them thoroughly, their bulk was reduced to 95 measures, so that a concentration of 5 per cent. had taken place, this amount was found to vary with the proportions employed.

It may be objected to this explanation, that some substances on mixture actually increase in volume, a fact, if true, quite incompatible with the above views. We believe, however, that more correct experiments will do away with the greatest number, if not the whole, of these exceptions.

The subject seems worthy of attention, as likely to throw great light upon some of our chemical theories, even from the above simple experiment of the lead drops, we think some inferences of the highest importance to atomic chemistry may be deduced.

specific gravity of mixtures of alcohol and water at every 0·5 per cent., and the result of a number of comparative trials which we have made upon it at different points have been highly satisfactory.

We have added a table of corrections, to be added or subtracted for each degree. The spirit under trial is above or below 60°, and will be found to give a sufficiently near approximation at temperatures between 50° and 70°, and will be even quite sufficient for a much greater range where a very great degree of accuracy is not required.

Alcohol per Cent.	Sp. Gr- at 60° Fah.	Cor. for each°	Alcohol per Cent.	Sp. Gr. at 60° Fah.	Cor. for each°	Alcohol per Cent.	Sp· Gr. at 60° Fah.	Cor for each°	Alcohol per Cent.	Sp. Gr. at 60° Fah.	Cor. for each°	Alcohol per Cent.	Sp. Gr. at 60° Fah	Cor. for each°
100·	·79460	48	79·5	·84840	47	59·	·89759	45	38·5	·94213	39	18·	·97382	19
99·5	·79568	48	79·	·84924	47	58·5	·89873	45	38·	·94311	39	17·5	·97443	18
99·	·79716	48	78·5	·85136	47	58·	·89988	45	37·5	·94406	39	17·	·97504	18
98·5	·79845	48	78·	·85248	47	57·5	·90101	45	37·	·94502	39	16·5	·97564	17
98·	·79973	48	77·5	·85369	47	57·	·90215	45	36·5	·94595	38	16·	·97625	17
97·5	·80102	48	77·	·85491	47	56·5	·90328	45	36·	·94689	38	15·5	·97686	16
97·	·80231	48	76·5	·85612	47	56·	·90442	45	35·5	·94782	37	15·	·97748	16
96·5	·80361	48	76·	·85733	47	55·5	·90554	45	35·	·94876	37	14·5	·97806	15
96·	·80490	48	75·5	·85854	47	55·	·90666	45	34·5	·94967	36	14·	·97865	15
95·5	·80620	48	75·	·85975	47	54·5	·90778	45	34·	·95059	36	13·5	·97930	14
95·	·80750	48	74·5	·86095	47	54·	·90891	44	33·5	·95148	35	13·	·97995	14
94·5	·80880	48	74·	·86216	47	53·5	·91005	44	33.	·95238	35	12·5	·98059	13
94·	·81010	48	73·5	·86336	47	53·	·91119	44	32·5	·95325	34	12·	·98124	12
93·5	·81146	48	73·	·86456	47	52·5	·91232	44	32·	·95412	34	11·5	·98188	12
93·	·81271	48	72·5	·86576	46	52·	·91345	44	31·5	·95496	33	11·	·98253	12
92·5	·81398	48	72·	·86696	46	51·5	·91487	44	31·	·95581	33	10·5	·98320	12
92·	·81524	48	71·5	·86815	46	51·	·91570	43	30·5	·95662	32	10·	·98387	12
91·5	·81660	48	71·	·86935	46	50·5	·91680	43	30·	·95743	32	9·5	·98456	11
91·	·81797	48	70·5	·87053	46	50·	·91791	43	29·5	·95822	31	9·	·98525	11
90·5	·81953	48	70·	·87172	46	49·5	·91896	43	29·	·95902	31	8·5	·98595	10
90·	·82108	48	69·5	·87291	46	49·	·92001	43	28·5	·95979	30	8·	·98666	10
89·5	·82286	48	69·	·87411	46	48·5	·92115	43	28·	·96057	30	7·5	·98739	10
89·	·82465	48	68·5	·87529	46	48·	·92229	43	27·5	·96132	29	7·	·98812	10
88·5	·82594	48	68·	·87648	46	47·5	·92337	43	27·	·96207	29	6·5	·98887	10
88·	·82724	47	67·5	·87767	46	47·	·92446	43	26·5	·96279	28	6·	·98963	10
87·5	·82857	47	67·	·87886	46	46·5	·92554	42	26·	·96351	28	5·5	·99041	9
87·	·82982	47	66·5	·88006	46	46·	·92663	42	25·5	·96421	27	5·	·99120	9
86·5	·83112	47	66·	·88123	46	45·5	·92770	42	25·	·96491	26	4·5	·99201	9
86·	·83242	47	65·5	·88238	46	45·	·92877	42	24·5	·96558	25	4·	·99282	9
85·5	·83371	47	65·	·88354	46	44·5	·92986	42	24·	·96626	24	3·5	·99373	9
85·	·83499	47	64·5	·88473	46	44·	·93095	41	23·5	·96691	23	3·	·99464	9
84·5	·83627	47	64·	·88593	46	43·5	·93200	41	23·	·96757	23	2·5	·99547	9
84·	·83754	47	63·5	·88709	45	43·	·93306	41	22·5	·96821	22	2·	·99630	8
83·5	·83881	47	63·	·88826	45	42·5	·93408	41	22·	·96886	22	1·5	·99721	8
83·	·84008	47	62·5	·88973	45	42·	·93511	41	21·5	·96949	21	1·	·99813	7
82·5	·84133	47	62·	·89121	45	41·5	·93612	40	21·	·97012	21	0·5	·99906	7
82·	·84259	47	61·5	·89208	45	41·	·92714	40	20·5	·97074	21			
81·5	·84385	47	61·	·89295	45	40·5	·93815	40	20·	·97136	20			
81·	·84509	47	60·5	·89411	45	40·	·93916	40	19·5	·97198	20			
80·5	·84633	47	60·	·89528	45	39·5	·94015	40	19·	·97260	20			
80·	·84757	47	59·5	·89643	45	39·	·94115	40	18·5	·97321	19			

Before leaving this part of our subject, there is another point which it will not be out of place to determine, the composition of the spirit, which, in the language of the trade and revenue, is denominated *proof*, and by reference to which, the value of all other spirits is ascertained.

The intention of Government being to levy a certain amount of duty upon the real quantity of alcohol contained in spirits, the amount of this duty must necessarily vary with the strength. In place of taking pure alcohol as the standard to which the value of such spirits are referred, a much inferior strength has been, wisely perhaps, made choice of, as it is of consequence that every standard of this kind should be that which is most commonly employed, besides the more important reason, that any small error in ascertaining the strength, &c., will be of much less consequence in an inferior than in a more valuable spirit.

The proportional value of spirits will be no less truly ascertained, by reference to the quantity of such standard spirit, that would be capable of producing or being produced by that given compound, provided it be certainly and precisely defined. This, unfortunately, can hardly be said to be the case.

The first attempt to fix it by parliamentary authority, was by the 2 G. III. c. xxv., by which it is enacted, "*That each gallon of spirits, of the strength one to six, under hydrometer proof, shall be taken and reckoned as seven pounds thirteen ounces the gallon.*"

The omission to fix the temperature, coupled with the awkwardness of describing a mixture, differing from proof rather than proof itself, and from which the latter could only be inferred, from a calculation, in which different data may be assumed, are the leading causes of all the uncertainty relating to this subject.

Unsatisfactory as this first attempt was, it was contrived to render it still more so, by the one which succeeded; 27 G. III. c. xxxi., enacting, "*That all spirits shall be taken to be of the degree of strength, which the said hydrometer, called Clark's, shall denote it to be.*"

This instrument was, perhaps, the very worst that could have been made choice of, different instruments, varying not only from each other, but from themselves, to the amount, in some of the higher indications, of nine or ten per cent.

The deficiency of these acts was soon universally acknowledged; and shortly after the passing of the latter, application was made by government to the Royal Society, for the institution under their direction, of a series of experiments, by which the actual relative values of spirits and the consequent just appreciation of the duties to be paid by each, might be ascertained.

The experiments that we have already had occasion to notice were the result of this application. Unfortunately, however, in place of fixing the value of the (at that time considered) legal proof spirits, and determining the relative value of other strengths to this, they thought proper to propose a new standard, and drew up the result of their experiments so as to be applicable to this.

Leaving out of view the temporary inconveniences that would have been experienced by the trade and revenue officers, from the adoption of this proposal, it would be difficult to point out any advantage that would have been gained, by changing the standard from 0·92, to an equally arbitrary point 0·825, while very satisfactory reasons might be adduced against it. Hence, though these tables undoubtedly afforded data for a very accurate system, from not meeting the immediate views of Government, little advantage was taken of them, and the uncertainty in the standard was allowed to continue.

One more attempt has since been made to overcome this difficulty, a difficulty, which certainly it is surprising should have been allowed to remain, in spite of three successive enactments, for the express purpose of doing away with it; since, had a certain specific gravity at a fixed temperature, been declared to be that of proof spirit, the question would have been at once clearly and definitely settled, it remains to be seen, how far this has been accomplished by the succeeding act, the one by which proof spirit is at present defined. The exact words of the act are,

"*That an hydrometer, called Sikes', had with great care been completed, and had by proper experiments made for that purpose, been ascertained to denote as proof spirits, that which at the temperature of* 51 *degrees, weighs exactly twelve thir-*

teenth parts of an equal measure of distilled water." 58 G. III. c. xxviii.

Three different specific gravities may, and have actually been deduced from the above as that of proof spirits by different writers, each of which, in one sense, must be considered as legal, and as agreeing literally with the words of the act.

This ambiguity arises from the omission to state the temperature at which the weight of water was to be considered as unity.

Hence, 1st. by considering this to be intended as 60°, the legal point at that time, the act is interpreted $\frac{12}{13}$ of 1= ·92308, the specific gravity of proof spirit at 51°; hence, it would be ·91921 at 60°.

2nd. By considering 51° as the point intended, we get ·92308 as the specific gravity of proof spirit at 51°. Water being, at the same temperature, or raising both to 60°, we get ·92003 as the specific gravity of proof spirit.

This last has most commonly been considered as the specific gravity of the spirits intended to be defined by the act as proof. That it really is not so, we shall show immediately, but that $\frac{12}{13}$ parts of the weight of an equal bulk of water at 51° considered as unity at 60°, is the legal specific gravity of proof spirit at 51°. The weight of a given bulk of water reckoned 1 at 60°, will, by Captain Kater's experiments, weigh 1·0004 at 51°, nearly $\frac{12}{13}$ parts of which= ·92338, is the specific gravity of proof spirit at 51°=·91957 at 60°.

From this ambiguity, it is obvious, that our present law, whatever may have been the intention of its framers, does not define proof as relates to spirits of other strengths. It is in fact, with a little alteration in its wording, precisely of the same import, as that of the 58 G. III. c. xxviii. above quoted, merely substituting Sikes' hydrometer for that of Clark's, or in other words, declaring that spirit to be proof, which is indicated as such, by Sikes' hydrometer; and though the fact of stating the weight, which trial had indicated such spirits to be, in terms of itself, in place of one to six under proof, must have been allowed a great improvement; the omission of not stating the temperature of the water has rendered it quite nugatory. So that in reality, the act does not advance us one step to the attainment of our object, as it simply substitutes one maker's instrument in place of another, leaving the vast interests depending upon its indication to the accuracy of the maker, or perhaps, his workman. We have no other method of settling this disputed point, but that of ascertaining the specific gravity of spirit indicated as proof at 60° by this instrument.

In different trials, we have found this to vary from ·91936 to ·91978, or rather, spirits within this range were all indicated as exactly proof by the hydrometer, evidence that it is not sufficiently delicate to show very small variations, but decisive enough in proving, that the specific gravity deduced by the latter of the above views ·91957 at 60°, is that of legal proof spirits, and therefore, containing by weight,

Alcohol . . .	49·2
Water	50·8
	100·0

When it is considered, that by the above act, Sikes' hydrometer is made a national standard, it becomes interesting to inquire, how far from the accuracy in its relative indication, or its intrinsic merit, it is entitled to such a distinction.

This hydrometer like every other, is simply a sp. gr. instrument, indicating the difference between the weight of an equal bulk of water, and of the liquid under trial. In place, however, of being so graduated as simply to give this, which is all that the instrument is capable of doing, the whole range of specific gravity which it takes in has been divided into one hundred parts. This, at the very first, has the obvious disadvantage of rendering its indication quite unintelligible, but through reference to a voluminous set of tables which accompany it, and which give the per centage as it is called, over or under proof, at every 0·2 of each of these hundred divisions.

There is some difficulty in exactly defining the terms, over and under proof, which are consequently very often misunderstood. If we mix 50 measures of proof spirit with 50 measures of water, from the concentration which takes place, this mixture will not be 50 per cent. under proof, but only 49. Again, if to 50 measures of proof spirit, we add water, till the bulk is exactly 100 measures, such a mixture, in the language of Sikes, will be 50 per cent. under proof. The term per centage, is in one sense, therefore obviously defective, since spirit for example of 50 per cent. under proof, is not composed of 50 of spirit + 50 water, but of 50 spirit + 51 of water.

Knowing the composition of proof spirits, we can easily calculate the per centage in these terms, of that at any other specific gravity, and the correspondence of the indication of the instrument with this, will be a proof of its accuracy, and vice versa.

The rule for this calculation may be represented generally, as follows:

Let s=the specific gravity of the liquid under tried.

,, c=its per centage of alcohol.

,, x=the proof spirit it contains per cent. or is capable of producing.

,, y=the per centage, in the language of Sikes' tables,

$$x=\frac{2{\cdot}0325203.\ s.\ c.}{{\cdot}91957}=2{\cdot}21029,\ s\,c = x.$$

and $y= \begin{matrix} x - 100 \\ \text{or} \\ 100 - x \end{matrix}$ as the spirit is over or under proof.

Thus, in the case of proof itself, we have

s = 91957, and c = 49·2, consequently,

x = 2·21029 × ·91957 × 49·2 = 99.999, and

y = in this case to 0·

The following table exhibits the correspondence between Sikes' Hydrometer, and the per centage calculated from the specific gravity by the above rule.

Sp. Gr. of the spirits tried at 60°.	Per Centage by Hydrometer.	Per Centage Calculated.	Difference.
·82580	61·5 O. P.	61·71	0·2
·83524	57·1	56·74	0·36
·90925	8·2	8·31	0·11
·91957	00·0	00·0	0·00
·93247	10·8 U. P.	10·757	0·043
·93442	12·7	12·636	0·064
·96350	45·4	44·63	0·77
·97904	71·3	70·14	1·16
·98700	84·4	83·2	1·2

The result of these experiments on the gravities above proof must be considered highly satisfactory, as evidence of the correctness of the instrument in this part of its scale; the differences not being greater, than may be allowed to proceed from inaccuracies unavoidable almost in performing such experiments. Below proof, on the other hand, the difference becomes more considerable than can be accounted for in this way, the error apparently increasing with the specific gravity of the spirit.

The instrument employed was wet, for the first time, in these experiments, after being received, warranted, from the hands of the maker; we have no reason to suppose, therefore, any accidental inaccuracy in it or its weights.

In each experiment, the specific gravity of the spirit was accurately taken, and, in the above table, to allow every thing in favour of the instrument, we have given that which came nearest the indication: hence, the difference, as deduced from the table, is less than a mean of the experiments would have given.

It may, indeed, be said that the error is as probably in our tables of the composition of spirits, as in the instrument; the result of the following experiments, we think, prove decidedly that this is not the case:

One part, by measure of proof spirit, was mixed with two parts of water, well shaken, and allowed to stand twenty-four hours; it is obvious that, supposing no condensation to have taken place, the mixture was exactly 66·666 under proof; but, from the effect of the condensation, would, in reality, be a little less than this, or 66·5.

The instrument, on trial, gave 68·9. The same experiment was repeated, with exactly the same result, though, by the weighing bottle, a sensible difference could be detected in the specific gravity.

The two mixtures were united and well shaken; the hydrometer still indicated the spirit as exactly 68·9 u. p. The specific gravity of this latter mixture, by a mean of several trials, was ·97688 at 60°, which, by calculation, gives 66·533 as the per centage of the spirit, certainly very near the truth.

A mixture of 25 parts of proof spirit and 75 of water, was found to be indicated by the hydrometer as 77·6 u. p

The specific gravity of this mixture was ·98187, at 60°, giving 75·04 u. p., being much nearer the truth than the instrument.

Other experiments were tried in the same way, but, as the results were precisely similar, we think it unnecessary to detail them, as the above, if thought worthy of confidence, are quite sufficient to warrant the conclusion that this legalized hydrometer is erroneous in its own indications, at strengths much under its proof point, to the extent of between two and three per cent.

We venture to give this opinion, even founded as it is on experiment, with much diffidence, well aware of the difficulty and numerous sources of error that have to be obviated in an investigation of this kind.

Another fact may be mentioned, however, which very powerfully supports the accuracy of the above conclusion viz., that in the re-distillation of low wines and feints, weak spirits obtained in the processes of the distiller, varying in strength from 50 to 90 under proof, the quantity of stronger spirit produced, is considerably greater than they actually contained, as indicated by the hydrometer. The average of this excess may be stated at about 3·2 per cent. This well known circumstance has been usually explained by distillers as originating from the presence of foreign matter in these weak spirits, evident, indeed, from their colour; its quantity is, however, in general, too trifling to account for the whole difference, though it will very satisfactorily explain why the increase is rather greater than the result of our experiments would indicate.

There is still another defect in this instrument, or rather, in its tables, giving rise to, perhaps, even more serious errors than the above, which has been long well known, though no attempt has been made to remedy it. No allowance is made for temperature; spirits are charged only by their per centage, the same at the temperature of 80° as at 30°; it is therefore obvious, that when both are brought to the temperature of 60°, the one will have paid a much greater duty per gallon than the other.

In conclusion, we must remark, that in legislating on any subject, but more especially when of such importance as the present, accuracy and simplicity ought to be the points aimed at; from the neglect of the latter, in the existing law, the former has been compromised.

It would, however, be no difficult matter to substitute a system possessing both the above requisites; simple, as being merely a statement of facts, and accurate as far as the state of Science will enable experiment to approach.

The standard, or proof spirits, should be clearly defined, and its specific gravity stated at a fixed temperature, and, probably, for this purpose, 62° Fahrenheit, would be the most convenient point, as that made choice of by the Commissioners for Weights and Measures, and, consequently, that at which the specific gravity, by altering the decimal points, gives the weight per imperial gallon in pounds avoirdupois.

Two very eligible points offer themselves for that of the standard spirit.

That composed of equal parts by weight of alcohol and water, or that proportion of the two at which the greatest condensation takes place.

Though the latter would be the most scientific, the former, as differing little from the present standard, would perhaps be preferred.

A simple specific gravity instrument, with the assistance of tables, containing the value of spirits at every other gravity, either by considering the proof spirit as unity, or expressed in per centages as now made use of, but referred to the same temperature 62°, is all that will be required.

Probably, giving tables constructed on both these principles would be found a still greater improvement, the former as affording a very simple means of ascertaining the value of, or duty to be paid per gallon by spirits of every specific gravity, the latter as necessary in estimating with facility the bulk of proof that any other spirit would produce.

ARTICLE IV.

Notice of some Recent Improvements in Science.

MINERALOGY.

THIS science has made rapid progress ever since minerals began to be arranged according to their strict atomic composition. In confirmation of this statement, it is only necessary to refer to the pages of foreign journals, and to those of our own country, but especially of the transactions of the Royal Society of Edinburgh. The arrangements, however, which have hitherto been made public, are not suited to the chemical systems of this country, and it is therefore, with pleasure that we inform our readers, that a system of Mineralogy, by Professor Thomson is in the press, completely adapted to the present state of the science, both as regards order and description. The following species have lately been analyzed, principally on the continent:

1. *Graphite* —A beautiful specimen of this mineral from Ceylon, found in Gneiss in small pieces about the size of a nut yielded: (*Edinburgh Journal, and Journ. der Chem. d' Erdmann*, 1833.)

Carbon	62·8
Iron	5·4
Silica	21·6
Alumina	9·3
Lime	0·2
	99·3

Anthracite, from the beds of Baconniere at La Chauniere, gave

Carbon	84·7
Water and bitumen	8·0
Iron pyrites . . .	4·3
Earthy matter . .	3·0
	100·0

(*Ann. des Mines*, vi.)

2. *Hydro-boracite*.—Resembles gypsum, spec. grav. 1·9. Before the blowpipe melts into a transparent glass, which does not change on cooling, and tinges the flame greenish. The mineral is slightly soluble in water, and is readily dissolved by nitric and muriatic acids with the assistance of heat. It contains

Lime . .	13·298	1 atom
Magnesia .	10·430	2 "
Boracic acid	49·922	2 "
Water . .	26·330	3 "
	100·000	

and its formula is $(C + M) B^2 + 3 Aq.$ (*Pogg. Ann.*)

3. *Spinelle.*—M. Hermann Abich (*Pogg.* 1831) has found this mineral composed of

Silica	2·25
Alumina	68·95
Magnesia	25·72
Peroxide of iron . .	3·48
	100·40

4. *Pleonaste.*—Consists of, according to Abich,

Silica	2·50
Alumina	65·27
Magnesia	17·58
Protoxide of iron .	13·97
	99·32

5. *Chabasite.*—E. Hoffman has given the following analyses of this mineral, from different localities: (*Pogg. Ann.*)

	Reibendorfal Bohemia. Sp. gr. 2·127	Fassathal. Sp. gr. 2·112	Parsburg. Sp. gr. 2·075
Silica . . .	48·18	48·63	51·46
Alumina . . .	19·27	19·52	17·65
Lime	9·65	10·22	8·91
Soda	1·54	0·56	1·09
Potash . . .	0·21	0·28	0·17
Peroxide of iron	—	—	·85
Water . . .	21·10	20·70	19·66
	99·95	99·91	99·79

6. *Radiolite.*—Pfaff found this mineral to consist of (*Schweig Seidel*, xxiii. 394.)

Silica	48
Alumina	27
Soda	10
Magnesia	3
Water.	10
	98

7. *Humboldtilite.*—Kobell finds this mineral composed of

Silica	43·96
Alumina	11·20
Lime	31·96
Magnesia . . .	6·10
Protoxide of iron .	2·32
Soda	4·28
Potash	0·38
	100·20

and its formula is $5\,\mathrm{Al.S} + 9\,\mathrm{CS} + 3(\tfrac{5}{6}\,\mathrm{M} + \tfrac{1}{6}\,\mathrm{F})\,\mathrm{S}^2 + \mathrm{N\,S}^2$

8. *Phenakite from Ural.*—Colour yellow, or like quartz. Sp. gr. 2·969; crystals rhombohedrons. The angle of the rhombohedron is very obtuse, being, according to measurement by the common goniometer, 114°. Colour, none. Before the blowpipe it does not fuse *per se.* Fuses with difficulty with borax, and salt of phosphorus. It is found in Siberia, and has received its name from its resemblance to rhombohedral quartz, (φεναξ deceiver.) Hardness greater than quartz, but less than topaz. It contains

Silica	54·54
Glucina . . .	45·46
	100·00

(Poggendorff Ann.)

9. *Magnesia,—protoxide of iron* —A mineral thus constituted has been described by Breithaupt. *(Jahrbuch.* vi. 1833.) It is brought from N. America, and is accompanied with uraniferous spinelle. The crystals are imperfect octahedrons; cleavage uneven and slightly conchoidal; lustre semi-metallic; colour deep greyish black, slightly magnetic; sp. gr. 4·418—4·420.

Before the blow-pipe infusible, *per se.* With borax it behaves like the tetaniate of iron. It consists of protoxide of iron, much magnesia, a notable quantity of tetanic acid, and a little alumina.

10. *Junckérite.*—The crystals of this mineral, according to Dufrenoy *(Ann. des Mines,* vi. 273.*)* are rectangular octahedrons, with nearly equal faces. Two of its cleavages are parallel to the diagonal planes of the octahedron, and

form between them an angle of 108° ·26; the third is perpendicular to the axes of the same octahedron, and lead to a rhomboidal prism under an angle of 108° 26′. Junckérite possesses a yellowish gray colour, very similar to certain varieties of Scheelin. Before the blow-pipe with borax it forms a yellowish, transparent, green glass. Sp. gr. 3·815. It was found in the mine of Poullaouen, (Finistere) in small quartz veins, which traverse the greywacké in which the mine exists. The name was applied in honour of M. Juncker the director, by M. Pailette sub-director, by whom the mineral was discovered. It consists of

Protoxide of iron . .	53·6
Carbonic acid . . .	33·5
Silica	8·1
Magnesia	3·7
Loss	1·1
	100·00

Most of the carbonates crystallize in rhombohedrons. Those which do not, such as the carbonates of barytes, strontian, lead, &c., possess a crystalline form analogous to arragonite. Analogy would, therefore, induce us to believe, that we know only one of the forms of these carbonates, and that if they were met with in another form, that form would be a rhombohedron. Junckérite presents a second example of a carbonate, occurring in the rhombohedral form, and in that of a right rectangular prism. The carbonate of lead crystallizes in the form of a right rhomboidal prism, under angle of 117°, which differs from arragonite by only 50 or 55 minutes; but the sulpho-carbonate of lead, from Leadhills, described by Mr. Brooke, occurs in rhombohedrons with an angle of 107° 30′.

Dufrenoy considers that this combination is not a distinct substance, but only a carbonate of lead mixed with sulphate of lead, because the two elements are not in definite proportions, and because it would present the third instance of a dimorphous carbonate, and we should then have a similar relation between the angles of the rhombohedral carbonates 105° 5′, 107°, 107° 30′, as with those of the right rhomboidal prisms 116° 5′, 117°, 118°. He conceives that the two forms which the substances endued with dimorphism present, are connected by a law like the two roots of an equation of the second degree, and that one being known the other may be deduced from it. The rhomboidal prism would be according to the few examples we possess, the form corresponding to the rhombohedron. He cites in favour of this idea, the cases of the *fer oligiste*, which crystallizes in octahedrons, and iron, which is observed sometimes in the form of octahedrons, and sometimes of rhombohedrons, but he does so cautiously, because he is not certain of the exact nature of these substances in their different crystalline states. He remarks, that the specific gravity of arragonite is a little above that of the carbonate of lime, being 2·9 to 2·7. The specific gravity of the prismatic carbonate of iron is 3·8, while that of spathic iron is 3·6. He infers, from these two examples, that when the atoms are so arranged as to affect the prismatic form, they are more condensed than when they unite to form rhombohedrons.

11. *Franklinite*, according to the analysis of Abich, consists of

Silica	·40
Alumina	·73
Peroxide of iron . .	68·88
Oxide of manganese .	16·32
Oxide of zinc . . .	10·81
	97·14

12. *Danaite* is found in Franconia. It is a gray metallic mineral, very brilliant. Sp. gr. 6·214. Possesses an arsenical smell when heated. According to Hayer it consists of

Sulphur	17·84
Arsenic	41·44
Iron	32·94
Cobalt	6·45
Loes	1·33
	100.00

It has been named in honour of Professor J. Dana. (*Americ. Journ.* iv. 386.)

13. *Hypochlorite.*—This mineral forms a superficial coating on clayslate. It is associated with native bismuth, arsenical cobalt, sulphur of arsenic, and quartz. Its texture is foliated; cleavage compact or slaty; lustre slightly vitreous; colour green, more or less translucid. Sp. gr. 2·935—3·045. (*Ann. des Mines*, vi.)

14.—*Antimonial Nickel.* (*Poggendorff Ann.* xxxi. 134.) H. Stromeyer and Hausmann have examined this mineral. It was found by Volkmar in the Andreasberger mountains, mixed with calcareous spar, galena, cobalt ore, and resembles *Kupfer* nickel, but is easily distinguished by the colour. It occurs in crystals of six-sided tables; fracture uneven. The extremities of the tables possess a strong metallic lustre. The colour of fresh pieces is copper-red, with a strong tinge of violet. The powder has a reddish-brown colour, and is darker than the colour of the fracture. It is not magnetic. Before the blowpipe it gives out neither a smell of garlic nor sulphur. Heated in a glass tube some antimony sublimes. Nitric acid separates the sulphur when galena is contained in it. The solution of this mineral in nitric, displaced by tartaric acid, gives, with sulphuretted hydrogen, an orange coloured precipitate, which is taken up by potash, and, by reduction with hydrogen, is converted into antimony. The solution, freed from antimony, affords, with carbonate of soda, an apple-green precipitate, which dissolves in ammonia with a sapphire blue colour. It consists, according to analysis, of

Nickel	28·946	- 27·054
Antimony	63·734	- 59·706
Iron	0·866	- 0·842
Sulphuret of lead . . .	6·437	- 12·357
	99·983	99·959

15. *Plagionite.*—The crystals of this mineral belong to the oblique rectangular prismatic system of Beudant. If we consider the faces belonging to an octahedron for the punvictur form, then the faces parallel to the plane of the two axes are truncatures of the anterior angles. They are implanted in quartz. Fracture conchoidal. G. Rose has

termed it plagionite, from (πλαγιος oblique) in consequence of the oblique form and inclination of the axis, which measures 107° 32′. It consists, according to Rose, of

Lead	40·52
Antimony . . .	37·94
Sulphur	21·53
	99·99

Besides simple sulphuret of antimony, in the Wolfsberg antimonial veins, there are a great many combinations of sulphuret of antimony and sulphuret of lead in different proportions, viz: zinkenite, 3 Sb. su. + Pb. su. Plagionite, Federerz, Bournonite. The two first have only been found at Wolfsberg. (*Poggendorff*, xxviii. 421.)

16. *Native Litharge* has been found half way up the volcanoes of Popocatepetl and Iztacictualt in Mexico, corresponding exactly in appearance and composition with that derived from the lead furnaces, (*Ann. des. Mines*, vi.)

17. *Arsenical Pyrites* has been analyzed by E. Hoffmann from four localities:

	Schneeberg.	Sladming.	Hartz.	Reichenstein.
Sulphur	0·14	5·20	11·05	1·94
Copper	0·50	"	"	"
Bismuth	2·19	"	"	"
Arsenic	71·30	60·41	53·60	65·99
Nickel	28·14	13·37	30·02	"
Cobalt	"	5·10	0·56	"
Iron	"	13·49	3·29	28·6
Serpentine . . .	"	"	"	2·17
	102·27	97·57	98·52	98·16

18. *Arsenic Glance.*—Karsten found the composition of a specimen from Marienberg, in Saxony

Arsenic	96·785
Bismuth . . .	3·001
	99·786

(*Schweig. Seidel*, xxiii. 390.)

19. *Sternbergite.*—Zippa finds this composed of

Silver . . .	33·2
Iron	36·0
Sulphur . . .	30·0
	99·2

equivalent to 4 F Su. + Ag. Su.

(*Poggendorff*, *Ann.* xxvii.)

20. *Melanochroite.*—This mineral is found in the neighbourhood of Beresow, in the Uralian Mountains, in limestone, where it is accompanied with vauquelinite, phosphate of lead, quartz, and galena; colour between cochineal and hyacinth; compact; crystals, rhomboidal prisms, with two large faces, which gives them a tabular appearance; edges, translucent; streak, brick-red; sp. gr. 5·75. Before the blowpipe fuses easily into a brown mass, which assumes a crystalline structure on cooling. In the reducing flame it is converted into oxide of chromium and metallic lead. It consists of

Oxide of lead . .	76·36
Chromic acid . .	23·64
	100·00

It is obviously, therefore, a subsesqui-chromate of lead. (*Poggendorff*, xxviii.)

21. *Chrome iron ore*, from Baltimore, was found by Abich to contain, (*Poggendorff*, 1831.)

	Crystallized.	Amorphous.
Silica	—	00·83
Alumina	11·85	13·85
Oxide of chromium . .	60·04	54·91
Protoxide of iron . .	20·13	18·97
Magnesia	7·45	9·96
	99·47	98·52

22. *White Arseniate of Iron.*—Kersten found a specimen of this mineral from Freiberg, to consist of

Arseniate of iron . .	70·70
Water	28·50
	99·20

(*Schweigger Seidel's Jahrbuch*, vi. 182)

23. *Polybasite.*—H. Rose has analyzed this mineral from the following localities:—

	Guarisamny, Mexico.	Schemnitz.	Freiberg.
Sulphur . . .	17·04	16·83	16·35
Antimony . . .	5·09	0·25	8·39
Arsenic	3·74	6·23	1·17
Silver	64·29	72·43	69·99
Copper	9·93	3·04	4·11
Iron	0·06	0·33	0·29
Zinc	0·00	0·59	0·00
	100·15	99·70	100·30

(*Poggendorff*, xxviii. 156.)

24. *Voltzite.*—This mineral is found at Pont Gibaud, in Puy de Dome. It possesses a pearly lustre; colour rose-red, or yellow; granular; fracture irregular; softer than glass; sp. gr. 3·66. It consists of

Sulphuret of zinc . .	82·92
Oxide of zinc	15·34
Peroxide of iron . . .	1·84
	100·10

(*Poggendorff*, xxxi.)

25.—*Carbonate of lead and zinc* comes from Mount Poxi, in Sardinia, in the form of small crystals, irregularly grouped together in rock quartz; white and translucid; hardness equal to calcareous spar; sp. gr. 5·9. It contains

Carbonate of lead, with traces of chloride of lead	92·10
Carbonate of zinc .	7·02
	99·12

(*Jahrbuch*, 3d, 1833, p. 335.)

26. *Gahnite*, according to the analysis of Abich, consists of

Silica	3·84
Alumina . .	55·14
Magnesia . .	5·25
Peroxide of iron	5·85
Oxide of zinc	30·02
	100·10

The specimen was from Fahlun.

27. *Blue Arseniate of Copper*, (*Jahrbuch*, 1st, 1833. p. 73.)

from Cornwall, consists, according to Trolle Wachtmeister, of

Oxide of Copper . .	35·19
Alumina	8·03
Peroxide of iron . .	3·41
Arsenic acid	20·79
Phosphoric acid . .	3·61
Silica and quartz . .	6·99
Water	22·24
	100·26

28. *Platinum*, in Siberia, is found in fine sand. A piece was obtained at Nischne Tagil, weighing 4 Kilogrammes, (8 lbs. 13 oz. 4 dr. avoird.) in 1827, and three bits in 1831-32, the two first weighing 8 kil. (17 lbs. 11 oz.) and the third 5 kils. (11 lbs. 1 oz. 1 dr.) It is accompanied with gold, osmium, iridium, magnetic iron, chromium, brown oxide of iron, oxide of titanium, epidote garnet, rock crystal, and sometimes diamonds. The sand is composed of jasper, quartz, and greenstone, and likewise small yellow crystals of rhomboidal, dodecahedrons, resembling chrysoberyl, the nature of which is not known. Among the rocks which accompany platinum in the Uralians, serpentine is the most remarkable. Gold appears generally to exist in the same rock with platinum. (*Journ. de St. Petersburg*, 1833.)

29. *Osmium and Iridium.*—Two minerals have been obtained in the Uralians, composed of these two metals. One found at Newiansk possesses a compound crystalline form, consisting of the combination of a double pyramid with six faces, with a right hexagonal prism. It possesses a blue metallic lustre. Hardness nearly that of quartz. Sp. gr. 19·386—19·471. Before the blowpipe, on charcoal, it does not decompose. In the matrass with saltpetre a feeble smell of osmium is observable. It is found in the auriferous sand of Newiansk, 95 versts to the north of Katharinenberg. It is also observed at Bilimbajewsk and Kyschtim, and several other places in the Urals. The crystals of the variety from Nischne Tagil have the same form as the preceding. The colour is blueish-gray, analogous to that of sulphuret of antimony. Hardness about that of quartz. Sp. gr. 21·118. Before the blowpipe, on charcoal, becomes black, and loses its lustre, and disengages a pungent smell

of osmium, which acts upon the eyes. It is found in the platiniferous sand of Nischne Tagil. It is never associated with gold.

These two combinations of osmium and iridium, possessing the same shape, G. Rose considers that the idea of the isomorphism of the two metals is confirmed. The Nischne Tagil variety, which contains more osmium than that of Newiansk, having a higher specific gravity, it follows that osmium is heavier than iridium. Osmium ought then to have a higher specific gravity than 21·118. Hence, it is obvious that Berzelius' sp. gr. 10 is quite erroneous. *(Poggendorff Ann.* xxix. 452.)

30. *Native iridium* has been found at Nischne Tagil, accompanied with gold and platinum. It is in grains of the colour of silver, verging towards yellow, possessing a strong metallic lustre, and is extremely hard. Sp. gr. 23·5—23·6. Insoluble in acids. It is combined with some osmium, and may be easily fused. *(Breithaupt in Schweigg Journ.* 1833.*)*

31. *Chemical composition of Native Gold, particularly Uralian Gold.*—Gold is never found in the earth in a pure state, but is always combined with more or less silver.

Fordyce examined a specimen from Konsberg, in Norway, which consisted of 28 gold, 72 silver in the 100 parts. Klaproth obtained gold from Schlangenberg in the Altai, 64 gold, 36 silver; and Lampadius, from an unknown locality, procured 96·6 gold, the remainder being silver and iron. Boussingault analyzed gold from different places in Colombia, and found it combined with silver in variable quantities, but always in definite proportions, viz.: one atom of silver with 2, 3, 4, 5, 6, 8, and 12 atoms gold. *(Ann. de Chimie,* xxiv. and xlv.) G. Rose, while travelling in Siberia with Baron Homboldt, made a collection of gold ores for the purpose of determining the truth of the French chemist's position.

In the Uralian Mountains, gold is found in rocks and distributed among sand. Previous to 1819, it was extracted from rock veins, but after this period, the discovery of sand containing it occasioned the abandonment of working the rock mines. Gold in rocks is found always in quartzose veins; at Beresow, occurring in the form of crystals, and at Newiansk, in plates, while at Czarewo Alexandrowsk, pieces are met with which weigh from 13 to 24 livres, (18 lbs. to

96 lbs. Troy.) Gold produced by the different workings is assayed in the mints of Katharinenburg, and St. Petersburg.

The following table exhibits the composition of gold from different localities, all being richer than gold from Colombia and Siebenburg:—

		Gold.	Silver.
Katharinenburg . . .	sand	93·01	6·99
Hiel	rock	87·40	12·60
Miask	sand	93·0	7·00
Bogowslowsk . . .	—	88·80	11·20
Kuschwa	—	90·30	9·70
Werch Isetsk . . .	—	92·70	7·30
Nischne Tagil . . .	—	90·73	9·27
Kaslinski	—	91·97	8·03
Newiansk	—	91·42	8·58
Do.	rock	92·95	7·05
Sisersk	sand	91·78	8·22
Ufaley	—	91·45	8·55
Schaitansk	—	95·10	4·90
Bilimbajeusk	—	93·54	6·46
Do.	—	91·24	8·76
Bewdinski.	—	93·33	6·67
Usewoledski . . .	—	89·01	10·99
Bissersk	—	88·72	11·28

Before the blowpipe, pure gold and pure silver are readily distinguished by their fusing into a transparent and colourless glass, with salt of phosphorus in the exterior flame. In the interior flame, if the quantity of silver is small, the glass is opaline and yellowish, but if great, altogether yellow and opaque. The native alloys act in the same manner, but an alloy which contains only ¼ per cent. of silver has no action on salt of phosphorus.

When the quantity of silver is small, which can be easily detected by the golden colour of the alloy, the metals may be dissolved in a covered capsule, in aqua regia. The greatest portion is converted into chloride of silver. Decant the solution and remove the chloride by the aid of a glass rod, and add a new dose of acid. If the alloy contains more than 20 per cent. of silver, the chloride sticks to the glass, and gives rise to inaccuracy. The two acid solutions should then be diluted. The first is only slightly muddy; for, it appears that a saturated solution of gold does not dissolve a notable quantity of chloride of silver; the second, on the contrary, deposits a considerable quantity of this substance. When the whole chloride has been deposited it should be filtered and weighed, after being dried and fused in a porcelain crucible. Evaporate the liquid in a porcelain crucible, to drive off the excess of chlorine, and when fumes cease to be given off, treat it with oxalic acid. Place the liquid in a glass defended by a convex cover, in order that no gold may be mechanically removed with the carbonic acid, and allow the glass to remain for 24 hours in a warm place. Filter the liquid, evaporate to dryness, and pass a stream of sulphuretted hydrogen through the solution of the residue in muriatic acid. A trace of copper is thus separated, and the iron may be removed by hydro-sulphuret of ammonia.

When the gold contains more than 20 per cent. of silver, the correct plan is to assay the alloy in a cupel with lead and silver, and to treat the new alloy with nitric acid, which takes up the silver only. Gay Lussac shewed that a loss of silver is sustained to a small extent in this way, and G. Rose, to obviate the inadequacy of this plan, tried a number of others, and at last hit upon one which he considers better than any other yet devised. Fuse the native gold in a small porcelain crucible with lead, by means of a lamp supplied with a double current of air. Digest the mass in nitric acid; detach it from the crucible, and place it in a glass vessel, adding a new portion of nitric acid diluted with water, in order to dissolve the nitrate of lead; wash the residue; dissolve it in aqua regia; precipitate the chloride of silver dissolved, diluting the liquid with water; filter the liquor and evaporate to dryness. Dissolve in water, and precipitate the gold by means of muriate of iron. Sulphated protoxide of iron does not answer for the precipitation, because the gold in solution may still contain a little lead. Dilute the nitric acid solution with much water; then treat it with chloride of lead, and not with muriatic acid, which may precipitate part of the lead in the state of chloride. Place the liquid in a warm place, to favour the precipitation of the chloride of silver, and when the solution has become clear, collect the chloride upon the filter which was used to filter the solution of gold. The minute portion of iron cannot be appreciated, on account of the quantity of lead.

Rose has never found platinum and gold associated. He deduces from his analyses several important consequences.

1. Native gold does not contain gold and silver in definite proportions.

2. Gold and silver being thus combined in indefinite proportions, he concludes that they are isomorphous, an inference which cannot be deduced with the same certainty from the identity of their crystals.

3. Native gold always contains silver, copper, or iron. The smallest quantity of silver was in a specimen from Schabrouski, which contained ·16 per cent. of silver, but ·35 per cent. of copper were present.

4. The specific gravity is in the inverse ratio of the proportion of silver contained in the mineral.

In general, fused gold has a greater density than native gold, which, however, may be owing to cavities in the latter.

5. Different specimens from the same locality vary in composition.

6. Gold found in veins varies in different parts of the same mine.

7. He finds that the gold from sand contains more silver than that from veins. The proportion in the former being 89·7 per cent. of silver, and in the latter, 79·1, a fact completely contrary to the determination of the Russian government, for the mining of gold has entirely yielded to the process of procuring it from sand. (*Poggendorff Ann.*)

METEORIC STONES.

According to Hofrath Stromeyer, copper exists in all meteoric masses. He examined specimens from Agram, Lenarto, Elbogen, Bitburg, Gotha, Siberia, Louisiana, Brazil, Buenos Ayres, and the Cape of Good Hope, and found in all of them an appreciable quantity of copper, varying from 0·1 to 0·2 per cent., and he came to the conclusion that the presence of this metal must be considered as constant a character of these substances as are the nickel and cobalt, which are found in greater proportion. (*Ann. der Physik*, xxvii. 689.)

Berzelius appears to have entirely overlooked this metal, in meteoric stones, for, in the analysis of a mass from Macedonia, he found

Silica		39·56
Protoxide of iron	13·83	18·83
Peroxide of iron	5·00	
Alumina		2·70
Oxide of chromium		0·50
Lime		1·86
Magnesia		26·30
Oxide of Nickel		0·10
Oxide of manganese		2·40
Potash		2·08
Soda		1·20
(*Kongl. Vetensk. Acad. Hand.* 1828, 156.)		95·53

H. Stromeyer examined a mass found at Magdebourg in 1831, the specific gravity of which which was 7·39, and its constituents,

Iron	74·65
Molybdenum	10·19
Copper	4·32
Cobalt	3·07
Nickel	1·23
Manganese	0·01
Arsenic	2·47
Phosphorus	2·27
Sulphur	·92
Silicon	·39
Carbon	·48
	10·000

Another body found near the Iron Works of Rothehutté, in the Hartz, afforded,

Iron	81·14
Molybdenum	1·08
Copper	7·69
Cobalt Nickel	2·40
Manganese	0·14
Arsenic	1·82
Phosphorus	·81
Sulphur	·62
Silicon	1·94
Carbon	·69
Calcium	·29
(*Ann. des Mines*, v. 568.)	98·62

Eaine.—Hermann,* of Moscow, examined a substance termed inflammable snow, which fell on the 11th April 1832, thirteen versts from Wolokalamsk, and covered a considerable space of ground, to the depth of 1 to 2 inches. Colour, wine-yellow, transparent; soft and elastic, like gum; sp. gr. 1·1; smelling like ranced oil; burns with a blue flame, without smoke; insoluble in cold water; soluble in boiling water, upon which it swims; soluble in boiling alcohol; dissolves also in carbonate of soda, and acids separate from the solution a yellow viscid substance, soluble in cold alcohol, and which contains a peculiar acid. Analyzed by oxide of copper, it gave

Carbon . .	61·5
Hydrogen .	7·0
Oxygen . .	31·5
	100·0

Hermann calls it *Eaine*, signifying *oil of heaven*.

MINERAL WATERS.

1. *Saline Springs.*—Boussingault has observed numerous springs of this nature among the Andes, with iodine in solution, and has remarked that the inhabitants who employed the water of such springs for domestic purposes were free from goitre, a disease extremely prevalent in the elevated parts of South America. They appear indiscriminately in the ancient and modern strata. The most remarkable are those of Guaca, near Medellia, in Antioquia, where the water proceeds from a micacious syenite, covered occasionally by quartzose sandstone, containing layers of pyritic lignite. At the village of Samson, on the Rio Negro, there is a spring which contains so much glauber salt that it is little used. It consists of

Chloride of sodium - -	43·
Sulphate of soda - - -	53·
Carbonate of soda - - -	1·0
Carbonate of lime - - -	3·0
Iodine - - - - - - - -	a trace
	1·

The district of Vega de Supia contains many saline springs. The principal rock is syenitic porphyry, which possesses traces of iodine. Five wells hold in solution the following substances:—

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* Pogg. Ann. xxviii. 566.

	Penol.	Muela.	Ciruela.	Mogan	Quinchia.
Chloride of sodium - -	81·	65·	59·	59·	83·
Chloride of calcium - -	9·	"	14·	"	"
Chloride of magnesium	1·	"	14·	"	"
Sulphate of soda - - - -	"	31·	"	37·	9·
Sulphate of lime - - -	9·	"	13·	"	"
Carbonate of soda - - -	"	4·	"	1·	"
Carbonate of lime - - -	"	5·	"	2.	8·
Carbonate of magnesia	"	"	"	1·	"
Iodine - - - - - - - - -	trace	trace	trace	trace	trace
	1·00	1·05	1·00	1·00	1·00

The valley of Magdalena possesses some iodine waters, and that of Cauca a great number.

On the plain of Mira is situated the base of the volcano of Cotocaxo. This plain is covered with sand and common salt, which is most probably derived from the subjacent trachyte, a rock containing glassy felspar imbedded in a basis of pyroxene.

2. *Water of Songragne.*—The temperature of this water is 7¼° C. (45½ F.) The spring is situated 706 metres (770⅔ yards) above the Mediterranean, and arises from a sandstone covered by secondary limestone. The salts present with their water of crystallization are, according to Berther,*

Sulphate of soda . . .	12·22
Sulphate of lime . . .	5·85
Sulphate of magnesia . .	4·68
Chloride of potassium . .	2·37
Chloride of sodium . .	74·88
	100·00

no trace of bromine or iodine could be detected.

3. *Soultz.*—This water has a specific gravity of 1·2884, and contains

Chloride of magnesium .	15·84
Chloride of calcium . .	6·19
Chloride of sodium . .	10·94
Chloride of potassium .	2·08
Bromide of sodium . .	0·50
	35·55

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* Memoirs, 313.

II. *Acidulous Waters.*—1. *Ueberlingen* on the borders of Lake Constance, possesses a copious acidulous spring, which has a temperature of 11° to 12°, and a density of 1·002, containing in the pound of 16 ounces, the following substances, by the analysis of Herberger. (*Journ. de Pharm.* xix. 192.)

Carbonic acid	266·6	cubic inches
Azote	43·3	
Proto-carbonate of iron .	43·424	grms.
Proto-carbonate of manganese	3·936	,,
Sub-carbonate of soda . .	14·600	,,
Sulphate of soda . . .	39·000	,,
Chloride of calcium . .	30·280	,,
Chloride of magnesium .	19·920	,,
Matter containing azote .	32·600	,,
Carbonate of lime . . .	88·520	,,
Alumina	6·000	,,
Silica	32·000	,,
	360.880	

The ochry substance which it deposits consists of

Hydrous protoxide of iron .	75·70
Oxide of manganese . .	00·30
Extractive matter . . .	00·60
Carbonate of lime . . .	13·45
Carbonate of magnesia .	2·95
Silica and alumina . . .	7·00
	100·00

This water is employed as a tonic.

2. *Cramaux.*—Its temperature is 4° 5′ C. (40° 1′ F.) 24 litres ($1\frac{4}{5}$ galls.) analyzed by Lamothe* afforded

Carbonic acid - - -	$\frac{1}{2}$	vol.
Carbonate of iron -	50	gr
Sulphate of iron - -	12	,,
Carbonate of lime -	48	,,
Sulphate of lime - -	24	,,
Muriate of lime - -	48	,,
Muriate of potash -	48	,,
Sulphate of magnesia	7	,,
Animal matter - -	3	,,
	240	

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* Journ. de Pharm. xix. 492.

3. *Acidulous water of Cambon.*—M. Blondeau, (*Journal de Pharm.* xxi. 674.) finds this water, which is situated in the department of Cantal, in a clay slate formation to contain

Bi-carbonate of soda,
Carbonate of magnesia,
Carbonate of lime,
Sulphate of soda,
Chloride of sodium,
Carbonic acid,
Traces of organic matter.

III. *Hot Springs.*—In the neighbourhood of the volcanoes of the Cordilleras, according to Boussingault, the temperature of thermal springs does not diminish with the altitude, from which it would appear, that the heat is derived from internal fires. They contain carbonates of lime and magnesia, chlorides of calcium, and sodium, sulphates of soda, lime, magnesia, traces of silica, carbonic acid, and sulphuretted hydrogen gases, (*Ann. de Chim.* 52. 181.)

IV. *Sulphureous Waters.—Waters of St. Genis.*—Professor Lavini procured from a litre (61·02 cubic inches) of this water, 19·5 cubic centimetres, (1·17 cubic inch) of carbonic acid, 5 (0·3 cubic inch) sulphuretted hydrogen, and 17·5 (1·05 cubic inch) of azote, and the following solid contents in the same volume of water:

Silica - - - - -	0·0254	grms.
Peroxide of iron- -	0·0066	,,
Alumina - - - -	0·0015	,,
Carbonate of lime -	0·0535	,,
Iodide of sodium -	0·0136	,,
Sulphate of soda -	0·0151	,,
Carbonate of soda -	0·2733	,,
Chloride of sodium -	2·1034	,,
	2·4924	

St. Genis is situated in Piedmont, about 4 leagues to the East of Turin. The temperature of the water is 5° R. (44°¼ F.) (*Memoire della Reale Accademia, delle Scienze di Torino*, xxxvi. 19.)

ARTICLE V.

On Dysluite. By THOMAS THOMSON, M.D., F.R.S., &c. Regius Professor of Chemistry in the University of Glasgow.

THE mineral of which I mean to give an account in this paper, was sent me at least seven years ago, by Dr. Torrey of New York; and some years after, I received a fresh supply from Mr. Nutall. Dr. Torrey informed me in his letter, that it had been discovered by two American Mineralogists, (I think they were Mr Keating and Mr. Vanuxem; though of this I am not quite sure, as I have not Dr. Torrey's letter at hand,) who gave it the name of dysluite, from its difficult fusibility with carbonate of soda, and who were engaged in analyzing it. This information prevented me from doing any thing more than giving it a cursory examination, which satisfied me that dysluite was a new mineral of rather a curious nature, and highly deserving the attention of mineralogists. Being unwilling to deprive the American mineralogists of the credit which might accrue to them from the analysis, I cautiously abstained from alluding to it, in a paper on the analysis of American Minerals, published in the Annals of the Lyceum of Natural History of New York, in the year 1828. But six years having elapsed since that period, and no analysis nor notice of dysluite having appeared in the interval, I take it for granted, that the American gentlemen have relinquished their intention of prosecuting the analysis, and that, therefore, I ought no longer to withhold the knowledge of this curious mineral from mineralogists.

Dysluite occurs at Stirling, in New Jersey, interspersed through a dark coloured limestone, and immediately mixed with crystals of octahedral iron ore and several other minerals, which it is unnecessary to describe here. I obtained it by dissolving the limestone in muriatic acid, and picking out the crystals of dysluite from the other crystals and grains with which it was mixed.

Colour yellowish brown, sometimes lighter, sometimes darker. In grains varying from the size of a mustard seed, to that of a pea; most of them crystallized in regular octahedrons. Texture foliated. Lustre of the faces of cleavage splendent, resinous, the faces of the crystals are frequently rough and have little lustre; easily frangible; hardness 4·5; specific gravity 4·551.

Before the blowpipe assumes a red colour but does not fuse, on cooling it resumes its natural colour and appearance. When heated on charcoal it becomes darker but does not melt. With carbonate of soda it does not fuse; but the soda while in fusion appears red, on cooling it resumes its white colour. With biphosphate of soda it does not fuse. The flux while in fusion assumes a fine red colour; when it becomes solid, the colour changes to yellow; and when quite cold, it resumes its usual colours and transparency, the assay remaining unaltered in the centre. With borax it dissolves very slowly. The bead is transparent and has a very deep garnet red colour.

1. To determine the component parts of this mineral, 100 grains of it were reduced to a very fine powder, and heated for an hour in a platinum crucible with thrice the weight of anhydrous carbonate of soda. The mixture had been fused, and when cold had a fine green colour, indicating the presence of manganese in the mineral. On digesting the fused mass in muriatic acid, 67 grains of the mineral remained undecomposed.

This residue was again fused with thrice its weight of carbonate of soda, and kept for an hour in a strong red heat; the fused mass was similar to the former. Being digested in muriatic acid, 33 grains of the mineral still remained undecomposed.

These 33 grains being treated with thrice their weight of carbonate of soda as before, the whole dissolved in muriatic acid, except a few flocks; which being heated a fourth time with carbonate of soda, and the mixture digested in muriatic acid, a complete solution was obtained.

2. The solution in muriatic acid had a strong yellowish red colour, shewing that the mineral contained much peroxide of iron. They were all mixed together and evaporated to dryness in a porcelain dish.

3. The dry mass, which had a yellow colour, was digested for an hour in water, acidulated with muriatic acid, and then passed through a filter. There remained on the filter a white powder, which, being washed, dried and ignited,

weighed 2 grains; dried by the blow-pipe, it melted with effervescence into a transparent colourless glass with carbonate of soda, and was not soluble in acids. It was, therefore, *silica*.

4. The liquid which had passed through the filter, together with the washings, was evaporated down to a manageable quantity. It was then neutralized and precipitated by caustic ammonia, added in excess. The whole was thrown on a filter, and the yellowish red residue on the filter well washed. The colourless liquid which passed through the filter was concentrated on the sand-bath, partly to drive off the excess of ammonia, and partly to reduce it to a manageable quantity; during the concentration white flocks fell. The quantity of this precipitate was much increased on adding carbonate of soda to the liquid.

This precipitate was collected on a filter, washed and dried. It possessed the following properties:

(1.) When heated to redness, it became yellow, but resumed its white colour on cooling.

(2.) Soluble in sulphuric, nitric and muriatic acids. The solutions colourless; and when neutral, possessed the peculiar taste which characterizes the salts of zinc.

(3.) The nitric acid solution precipitated in white flocks by caustic ammonia, re-dissolved by an excess of the precipitant.

(4.) Precipitated in white flocks by caustic potash, and re-dissolved by an excess of the precipitant.

(5.) Precipitated in white flocks by the alkaline carbonates, and not re-dissolved by an excess of the precipitant.

(6.) The sulphuric acid solution being cautiously evaporated, yielded transparent white crystals in four-sided prisms, almost rectangular, and easily recognizeable as sulphate of zinc.

It is obvious that the powder thus obtained was oxide of zinc.

To the liquid from which this precipitate had been obtained, oxalate of ammonia was added, and the liquid concentrated. In this way an additional precipitate was slowly obtained, which was oxalate of zinc.

All these precipitates being collected and exposed to a strong red heat, left 16·8 grains of oxide of zinc.

5. The red precipitate collected on the filter, (in paragraph 4) was well washed, and while still moist, was dis-

solved in muriatic acid. This solution was mixed with a great excess of caustic potash, and boiled for two hours in a porcelain vessel; the whole was then passed through a filter. The liquid which passed through was colourless; the matter remaining on the filter was dark red.

6. The potash solution which thus passed through the filter, together with the washings of the filter, was evaporated to dryness in rather a strong heat, and the dry residue being mixed with water, was digested (in the cold) in muriatic acid. A white powder remained undissolved, which, being separated and ignited, weighed 13·04 grains. It possessed the following characters:

(1.) When heated before the blow-pipe with nitrate of cobalt, it assumed a beautiful blue colour.

(2.) It dissolved by heat in sulphuric acid, and the solution being mixed with a solution of sulphate of ammonia, yielded crystals of alum. The powder then was *alumina*.

7. The muriatic acid solution being supersaturated with carbonate of ammonia, a white precipitate fell, which being separated and ignited, possessed the characters of alumina, and weighed 17·45 grains.

Thus, the whole alumina extracted from the mineral was 30.49 grains.

8. The dark red precipitate which was collected on the filter (in paragraph 5) being dried and ignited, weighed 50·53 grains.

9. It was digested in muriatic acid. The whole dissolved except a white powder weighing 0·996 grains. It was silica slightly impregnated with iron.

10. The muriatic acid solution was mixed with carbonate of ammonia till it was rendered as neutral as possible; indeed a few flocks had precipitated. It was then heated in a flask. Carbonic acid gas escaped in abundance, and the whole peroxide of iron was precipitated. The whole was thrown on a filter, the oxide of iron was collected on the filter and washed; the colourless solution which passed through being mixed with carbonate of ammonia, a white precipitate fell, which became brown by strong ignition, and possessed the character of oxide of manganese. It was equivalent to 7·76 grains of protoxide of manganese.

11. The peroxide of iron remaining on the filter being dried and ignited, weighed 41·774 grains.

From the preceding analysis the constituents of dysluite appear to be

		Atoms.	
Alumina	30·490	13·55	8·
Oxide of zinc	16·800	3·2	1·89
Peroxide of iron	41·774	8·38	4·96
Protoxide of manganese	7·760	1·69	1·
Silica	2·996	1·498	0·88
Water	0·400		
	100·12		

If we admit the silica to be only an accidental mixture, it is evident that dysluite consists of

8 atoms alumina
2 ,, oxide of zinc
5 ,, peroxide of iron
1 ,, protoxide of manganese

The alumina obviously acts the part of an acid, as it does in spinell, automolite, sapphirine, and candite. But in all of these, several atoms of alumina unite with one of the bases, which are manganese and peroxide of iron. But dysluite is composed of simple aluminates, the formula exhibiting its constitution being

$$5\,f\,\mathrm{Al.} + 2\,Z\,\mathrm{Al.} + mn\,\mathrm{Al.}$$

It is worthy of remark, that the crystalline form of dysluite is the regular octahedron, the same form which spinell and all the other crystallized minerals, in which alumina acts the part of an acid, assume.

Note.—The four minerals mentioned, in which alumina acts the part of an acid in union with a base, have their composition represented by the following formulæ, as deduced from analyses made in the laboratory at Glasgow.

1 Spinelle,	Sp. Gr.	3·523	. $\mathrm{M\ Al.}^{6}$
2 Sapphirine	,,	3·428	. $2\ \mathrm{M\ Al.}^{6} + \mathrm{MS}^{3}$
3 Candite	,,	3·617	. $8\ \mathrm{M\ Al.}^{2} + 5f\mathrm{Al.}^{2\frac{1}{2}}$
4 Automalite	,,	4·261	. $\mathrm{Z\ Al.}^{6}$

To which may be added

Chrysoberyl	,,	3·711	. $6\,\mathrm{Gl.\,Al.}^{6} + f\mathrm{Al.}^{1\frac{1}{2}}$

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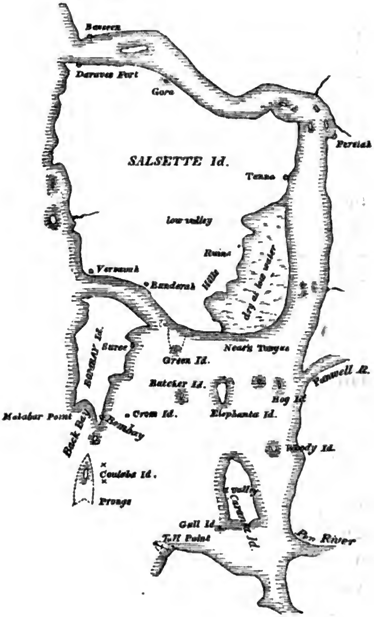
Basseen
Daravee Fort
Gora
Persiah
SALSETTE Id.
Tanna
low valley
Ruins
Hills
dry at low water
Versavah
Banderah
Bombay Id.
Suree
Neat's Tongue
Green Id.
Butcher Id.
Hog Id.
Panwell R.
Malabar Point
Back Bay
Bombay
Crow Id.
Elephanta Id.
Woody Id.
Coulaba Id.
Prongs
valley
Caranja Id.
Gull Id.
Tull Point
Pen River

ARTICLE VI.

Sketch of the Geology of the Bombay Islands. By ROBERT D. THOMSON, M. D.

ALTHOUGH Bombay has been known to Europeans since the year 1509, when the Portuguese Viceroy Ameyda captured a vessel in what the historian of the time has termed "the River of Bombaim,"[*] no connected view of the geological nature of the islands and antiquities in its neighbourhood has hitherto appeared. It is with a view of contributing to supply this omission, that the facts contained in this paper, which were acquired by observation, in the course of a short residence in that presidency in 1832, were drawn up.

The mean of fifty-nine observations in May, June, and July, 1832, gave me 83°·14′ for the temperature of the harbour of Bombay. This includes twenty-seven observations made after the setting in of the monsoon, on the 14th June. But a period of thirty-two days, immediately previous to this date, affords 83°·43′ for the mean temperature of the hot season; and twenty-seven observations gave for the commencement of the rainy season a mean temperature of 82°·85. The average temperature for 1803 was 81¼°, and for 1804, 80½°; and the number of rainy days for these years 102.[†]

The quantity of rain which fell in June, July, August, and September 1817, was 104 inches.[‡] On the 23d June 1817, no less than 9·3 inches of rain fell in one day. In fact, the inhabitants of temperate countries can form no idea of the quantity and force of the rain which falls between the tropics. The mean barometrical height for half of 1816 and 1817, was 29·986 inches.

The harbour of Bombay, situated on the Concan, or Pirate Coast of the western peninsula of Hindostan, is possessed, as its name implies, of peculiar excellence and capaciousness,[§] and has, therefore, been considered of great value ever since it became part of the British possessions. It may be described as forming the southern portion of a rectangular bay or recess, which lies between Tull Point in N. lat. 18° 47′, and Basseen, in N. lat. 19° 19′, and between the parallels of E. lon. 72° 47′ and 73° 3′, possessing, therefore, an extreme length of thirty-two miles, and an average breadth of sixteen miles. The island of Salsette occupies seventeen miles in the length of the northern part of the bay, acquiring a breadth of from fifteen to seventeen miles, while its circumference has been computed at seventy miles.

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[*] Sousa's "Portugues Asia," Tome. i. p. 146.

[†] Ann. of Philosophy, xiii. 145.

[‡] Ann. of Philosophy, xii. 212.

[§] From the Portuguese *Buon-Bahia*, good bay. The accompanying chart of the harbour and islands of Bombay, I have enlarged from that of Laurie and Whittle.

A considerable proportion of the remaining part of this bay is occupied by Bombay, Caranja, Elephanta, Butcher, Woody, and Cross Islands, which, being disposed in a crescentic manner, form the harbour of Bombay, an open and extensive bason eight miles in diameter, affording good anchoring ground and secure shelter for fleets of ships of the largest burthen. It is these insulated portions of land, that I have designated the Bombay Islands. The appearance presented by these islands is highly picturesque, as they are in many places adorned with thriving woods, which, between the tropics, always produce rich and refreshing scenery. But, in the Island of Bombay, the present trees appear of recent origin; for, we learn from older writers that the land was formerly swampy, and afforded no plants or trees worthy of mention. At present the higher parts of Salsette and Caranja are nearly destitute of trees, but they are for the most part thickly clothed with straggling jungle.

The general contour of these islands corresponds closely with that of the adjacent continent, and as far as the latter has been investigated, the formation appears identical. The altitude attained by the rocky masses in these insulated lands is never great, although they are all considerably elevated above the level of the ocean. The dark hills of Salsette reach the greatest height, next to them in order come the rugged masses of Caranja and Elephanta, but Bombay and the remaining islands approach more nearly the character of plains.

Before taking a separate view of each of the more considerable of these islands, it seems satisfactory to present at one view a description of the rocky masses and minerals, which form their essential constituents, and here it may be premised, that the rocks belong all to that class which has been termed trappean, or, theoretically, volcanic, as distinguished from the granitic series, or plutonic rocks.

1. Basalt, occurring in *situ* at the ruins of a chapel in Salsette; colour, dark-gray, or blackish, with numerous crystals of olivine and augite interspersed; fracture, irregular, dull. The upper portion of the ridges in Salsette appears to consist of this rock, or modifications of it.

2. Black Basalt, in Elephanta, often presenting a homogeneous aspect when fractured, but frequently containing minute portions of olivine, sometimes in rounded granules, at other times crystallized; texture highly indurated. This and the former variety, fuse before the blow pipe *per se* into a mass resembling pitchstone. The celebrated figure of the elephant, close to the village of Gallipooti, consists of this rock but it appears to be of limited extent.

3. Amygdaloid, appearing at the great temple of Elephanta, possesses a hard wacké basis, containing cavities filled with rock crystal and zeolites, &c., some of which are often met with enclosed in the strong mass in the form of rounded nodules, whose crystalline structure is not apparent until they are transversly fractured. The rock has a purplish aspect, and is evidently decaying in many situations, by the readiness with which the atmospherical influences act by the medium of the amygdaloidal cavities. Before the blowpipe *per se* this rock simulates fused basalt.

4. Yellowish gray claystone porphyry, at the lower cave of Elephanta. The predominating particles have a yellow resinous appearance, with a black basis.

5. Green claystone porphyry, appearing at Baboola Tank; fine-grained, and admitting of a good polish, interspersed with dark-coloured soft particles, which have an even fracture, and appear to be small masses of indurated clay.

6. Amygdaloid, with a light coloured porphyritic basis and green cavities, accompanied generally with large crystals of calcareous spar, from the neighbourhood of Parell. The calcareous spar is sometimes dark-coloured, probably from the effect of reflected light upon it in its impacted situation.

7. Numerous large fragments of shell conglomerates may be observed on the shore of Elephanta, consisting of a nucleus of porphyry, or amygdaloid, closely surrounded by adhering bivalves, which afford means of extending the limits of the growth of the mangrove.

The amygdaloidal cavities contain numerous species of various classes of minerals, but those which are of very common occurrence are included under these genera.

CLASS I.—ACIDS. GENUS, SILICA.

1. Rock crystal, termed *Palunca* in the Malabar language; *Spadika* in the Grantham dialect, occurs very abundantly in each of the islands, in the form of crystals, varying from the most minute size to half an inch in length.
2. Common quartz.
3. Milk and Rose quartz.
4. Chalcedony.
5. Amethyst.
6. Agate.
7. Carnelian, rare in the immediate neighbourhood of Bombay.
8. Oriental jasper, or blood stone, also rare, but abundant in Guzurat and Cambay.

CLASS II.—ALKALIES.

I. GENUS LIME.

Calcareous spar.

II. GENUS ALUMINA.

1. Mesolite, whose composition is expressed by the formula $3\,Al.\,S + (\frac{1}{2}\,C + \frac{1}{2}\,N)\,S^3 + 3\frac{1}{4}\,Aq.$*
2. Heulandite, observed frequently in Caranja and Elephanta, appearing in the form of large white crystals.

Of this last genus the number of species in India will be found extremely numerous, indeed there can be little doubt that this country will afford an immense field of discovery for future mineralogical investigators, nor is the scantiness of our mineralogical knowledge of India so much to be wondered at, when we reflect that, as yet, scarce a single addition has been made to our lists from the British possessions in the East, where, of all portions of the globe, geological facts point out the certainty of the greatest mineralogical stores.

The agate occurs in the form of round nodules, as well as in flat waterworn cakes. The chalcedony forms a basis generally upon which the rock-crystal and amethyst are seated, and in one beautiful specimen procured in Caranja, fine crystals of heulandite are similarly placed. The mesolite occurs in large radiated crystals, and likewise in the state of a lump-sugar appearance, which, when fractured, exhibits minute, slender, silky-like crystals, disposed in a radiated form.

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* The result of an analysis by me. *Jameson's Journal*, 1834.

Carnelian may be procured in the bazaars, brought from Cambay, where it seems to exist in considerable abundance. It appears that the specimens of this mineral which are worked into ornaments, are principally obtained from the neighbourhood of Broach, by sinking wells in the dry seasons in the channels of torrents, at the bottom of which they are found lying in the form of round nodules, intermixed with other rolled pebbles, probably forced by the impetuosity of the mountain streams from greater elevations, and generally weigh from a few ounces to two or three pounds.

Some of them are red, others pink, but the most delicate and beautiful is certainly the colourless or opaline variety. There can be little hesitation in affirming that similar sources of this mineral exist in the beds of the numerous streams which abound between Bombay and the Ghauts, and which add so materially to the grandeur of this romantic region.

A beautiful variety is brought to Bombay, containing elegant arborizations resembling the ramifications of inclosed mosses, a phenomenon which in many instances appears to be justly attributable to such a cause.[*]

Bloodstone, or oriental jasper, as sold in the town by the Parsees, appears also to be imported from Guzurat, and the adjacent territories. It is characterized by presenting a greenish appearance, with numerous blood-red streaks or veins traversing it in various directions. It is to the latter species, or to the mock pearls so frequently employed as ornaments by the inferior castes, that we are to refer the expression of the historian of Alexander: "lapilli ex auribus pendent."[†] But with regard to the "Gemmas margaritasque mare litoribus infundit," it is not easy to give a satisfactory explanation, although the latter obviously relate to the pearls of the Indian seas.

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[*] The remark of Pliny, "Infestantur plurimis vitiis—aliis capillamentum rimæ simile," with regard to rock-crystal, refers to the presence of Titanite. *Hist. Nat. Lib.* xxxvii. c. 2.

The same naturalist observes of rock-crystal, "Oriens et banc mittit, sed Indicæ nulla præfertur." *Hist. Nat.* xxxvii. 2. Which is ignorantly denied by Garcias ab Orto, who was for several years Viceroy of India. He says "Nullo autem ex prædictis loco crystallus invenitur quemadmodum nec per universam Indiam." *Hist. Arom. et Simplic lib.* i. c. 47, p. 171.

[†] Quint Curt Ruf. l. viii. c. ix.

We proceed now to a separate sketch of the islands, in the order of their importance.

BOMBAY ISLAND.

The whole island may be considered as a plain, variegated on the east with considerable undulations, which form the small eminences termed Mazagon, Parell, and Oblong hills. The southern part divides into two necks of land, of which the eastern portion, a low and flat surface, affords the site for the Fort and Dungeree, or the Black Town, and leaving an intermediate space called the Esplanade, terminates at Mendam's Point, the commencement of the Coulaba Causeway. The western promontary is considerably elevated, consisting principally of Malabar Hill, which lies near the entry of the harbour, and terminates at Malabar Point. Included between these points, with a crescentic outline, as between the prongs of a fork lies Back Bay, a considerable portion of water, with a sea communication, occupying a span of 2½ miles, the total mean breadth and length being about 1½ and 1¾ miles respectively. The water is shoal, having a depth of 2½ fathoms in the centre, and contains several sands, sunken rocks, and others exposed at low water.

The essential composition of this tract is claystone-porphyry and amygdaloid, and in some places, as on Malabar Hill, basalt shews itself, each corresponding with the varieties described, but seeming to vary with regard to the proportion of the bases and the magnitude of the cavities, and consequent quantity of the mineral contents. From Mendam's Point, a ledge of amygdaloid runs out south-west by south, to form a junction with Coulaba or Old Woman's Island, a flat and rocky mass, thinly covered with soil, which barely conceals the subjacent rocks, bearing every mark of having been at some period a continuous portion of that promontary of the island of Bombay upon which the town is situated. Advantage has been taken of this ledge to form a connecting causeway between the two islands, which is left quite dry at low water, so that a free land communication may be kept up in such circumstances. The prevailing rocks in this little insulated land are the same as those already mentioned, with the occasional appearance of basalt as if in dykes. At the southern point a dangerous rocky mass extends out to sea nearly three miles in length, assisting, with the aid of Tull Reef, in rendering the mouth of the harbour extremely narrow, for, if we deduct these obstructions to navigation, its span is not above four miles, although the distance from Coulaba to the nearest point of the continent equals seven miles.

The Coulaba Reef has been termed, from its forked figure, the Prongs, and appears to consist of the general rock, in a highly indurated form. The same series occurs at the New Bunder, by the Apollo Gate, where the amygdaloid appears to lie over the porphyry, which is very hard when first exposed, and is employed as a building material. The New Bunder is formed of it; but notwithstanding the excellent quality of the stone for enduring the effects of aqueous friction, it is remarkable that an effectual plan has not been fallen upon to render the building of the jutty durable, as it is continually undergoing displacement from the action of the tide. The utility of the Bunder cannot be disputed for the numerous ships which annually increase in frequenting this excellent port, and the situation of this quay, from its being exterior to the fort, is very important, and is perhaps safer than the Old Bunder during the height of the monsoon.

To the north of the town the surface begins to rise gradually until the small eminence of Mazagon is formed. Beyond it are Parell and Oblong Hills, all preserving a rounded outline, thinly sprinkled with cocoa-nut trees, (Cocos nucifera) and affording some pasture land. At Baboola, a tank has been cut out of the solid rock, supplied with a broad flight of steps, to enable the inhabitants to have free access to the water, which they employ for all purposes. It is from similar reservoirs that the principal supplies of water for domestic purposes are obtained, and for the use of the crews of ships visiting the harbour.

As much discussion has taken place with regard to the influence which water procured from such sources may have upon the health of seamen, by affecting the alimentary canal, and, as the solution of the difficulties of the inquiry are very closely connected with the geological nature of the country, a few words upon the subject may not be out of place here. The whole of the soil which covers the island being extremely thin, it is obvious that the bottoms of the tanks, which are several feet below the level of the surrounding surface, must consist of solid rocks, and the margins being fortified with artificial building, we see that the water can have little opportunity of acting upon the soft soil, so as to produce a mixture of the earthy particles, and hence, that the substances of a saline nature in solution must derive their origin from the disintegrated rocky mass. A muddiness, however, generally exists in these waters, which appears to be produced by the agitation excited by the natives entering for the purpose of carrying off the water, and for bathing; but the proportion of mechanical mixture thus occasioned does not necessarily exist in general to any greatly appreciable amount, because, when the cause of excitement is removed, the commingled matter speedily subsides. The temperature is always equal or above that of the atmosphere, and in the dry season may be rated at from 80° to 86°. It affords the following results with re-agents:—

1. A solution of acetate of lead produces a copious white flocky precipitate.
2. A slight precipitation with oxalate of ammonia.
3. A muddiness with muriate of barytes.
4. A milkiness with lime water.
5. A precipitate with nitrate of silver.

From these facts we may deduce that the water contains in solution (1.) a quantity of vegetable or animal matter. Judging by the eye of the relative proportions of the precipitate by acetate of lead in the Thames and Bombay water, we should be inclined to refer the maximum to the former, and no one will affirm that the water procured from the Thames is pernicious to health.

(2.) Small quantities of
Chloride of sodium
Sulphate of lime
Carbonate of lime.

The animal and vegetable matters are derived, there can be little hesitation in concluding, from substances which readily gain admittance in consequence of the exposure of the tanks, and the presence of the saline matter must be attributed to the same sources as in other similar situations, their small proportions being explained by the want of free communication between the water and the soluble portion of the earth.

The rock at Baboola is close grained, and is extremely hard, approaching in some measure to a green stone, as it appears sometimes in Scotland, with the aspect of an aqueous deposit. It affords an excellent material for mending the roads, which for their smoothness cannot be surpassed. This rock appears limited in its range; for at Parell, amygdaloid occurs with very large cavities, filled with the usual mineral. The northern portion of the island is similarly constituted, presenting nearly a level surface, thickly clothed with a great variety of trees and shrubs,* which afford a grateful shade from the overpowering influence of the solar rays, "vim solis umbræ lævant." The coast is low and rocky with the water gradually shoaling to the land, which at ebb tide leaves a dry and pleasant beach. The amygdaloid shews itself frequently in the form of half sunk rocks and dangerous ledges, especially along the Coulaba shores, but suffering in the lapse of time from the action of the sea, and occurring remarkably in conjunction with the clay-stone porphyry, the latter often rising up between two rounded masses of the former, sometimes placed above it, at other times under it, both being traversed frequently with basaltic dykes. All these rocks at the shore may be observed covered with shells, and their surface with a decomposed powdery matter, which on inspection turns out to be the basis of the rock crumbling into dust. At the distance of two miles from the town, many of the shells which abound so profusely on the sea-shore are calcined, by which process, they are converted into caustic lime, which the natives term *chunam*, a substance in great request, both as a mortar, and as an edible rolled up in the *betel* leaf. The latter habit, which has been denominated by some writers a luxury, ought rather to be termed a necessary practice, as we find it prevailing wherever the sole articles of diet are procured from the vegetable kingdom, the different substances employed fulfilling the same end, whether it be on the coral rocks of the Pacific, the arid deserts of Africa, or the interminable forests of America.

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* Among the trees of the island, the *Ficus religiosa* and *Indica* are the most stately, which appear to have attracted the attention of Europeans, as early as the time of Alexander the Great, if we may judge from the admirable description of Quintus Curtius, "Plerique rami instar ingentium stipitum flexi in humum rursus, qua se curvaverant, erigebantur, adeo ut species esset non rami resurgentis, sed arboris ex sua radice generatæ."—*Q. Curt. Ruf.* lib. ix, c. 1.

"Branching so broad and long, that in the ground
The bended twigs take root, and daughters grow
About the mother tree."—Milton.

The variety of trees and shrubs is great, but perhaps, the finest ornaments are, *Morinda citrifolia, Capparis acuminata, Artocarpus integrifolia, Terminalia alata, Getonia floribunda, Michelia champaca, Mimusops elengi, Grewia microcos,* and *Orientalis, Annona reticula* and *squamosa,* and *Tamarindus Indica,* which if any members of the vegetable kingdom can be considered as indigenous in this island, must hold the highest rank.

SALSETTE ISLAND.

The description of the geological structure of one of these islands, may be said to include almost the particulars of the whole, but for the sake of greater perspicuity, we have ventured to consider them separately. The essential composition of Salsette, is clay stone porphyry and amygdaloid, corresponding with those rocks in Bombay, but basalt occurs in very considerable tracts, and assumes more decided forms. The island is very irregular in its surface, consisting of ridges and intervening vallies, which in combination afford agreeable scenery.

The basalt forms two ridges which run parallel to each other, the one on the west and the other on the east of the narrow strait which separates the island from the continent, appearing above the amygdaloid which forms the base of the hills; and therefore, leading us to conclude, that its ejection has been subsequent to that of the amygdaloid.

The alteration which the eruption of the basalt has produced on the masses through which it has been forced, by rendering the two rocks at the point of contact similar, and as if passing into each other by a gradual transition, are sufficiently obvious, but at the same time, the two varieties are as distinct as any of the projected series in general appear, so that in a theoretical nomenclature, (the establishment of which, it must be admitted, is not for the advantage of science,) not only the varieties of the trap formation should be discriminated, but the whole group should have an appellation, indicative of its production at a distinct period, and under different circumstances, from modern volcanoes. The term subaqueous volcanic rocks, expresses the hypothetical nature of their ejection.

In the centre of the island are situated the celebrated temples of Salsette, or rather their remains, since they have received great mutilation, not from the influence of natural causes, which from the hardness of the rock of which they are formed, they are calculated in a great measure to withstand, unlike the polished remnants of Greece and Rome, which are daily dissolving in the very rains which nourish the earth,* but from the hands of barbarous men.

It is not our purpose to describe them; it is sufficient to refer to accurate details respecting their appearance and size, which have afforded subject of admiration to numerous ages.† They are literally caves in hills, composed of porphyry and amygdaloid, thus differing from the pagodas on the coast of Malabar which consist of black basalt.‡

The Portuguese, who were the first European settlers in this country, justly merit the high degree of reprobation, which has been attached to their conduct, in the destruction of these extraordinary antiquities, for they must have been infatuated with the most determined intention of mutilation. The date of this dilapidation may be reckoned about the year 1564, as we learn from the historian of that period; that D. Antony de Noronha, the 9th Viceroy, and 23rd Portuguese governor of India, who succeeded John de Mendoça in 1564, and held the office till 1567, finding the people incorrigible, notwithstanding the exertions of the religious of the society of Jesus, who had laboured indefatigably for the conversion of infidels, and had sent some of their number into the island of "Salsete," which contained 66 villages of pagans; destroyed all their pagodas to the number of 200.* The soil in this neighbourhood is highly improveable, if we may judge from the flourishing appearance of the gardens at Powey, and the quantity of product raised. In the low valley which runs towards the centre of the island, the suface is completely covered with a coating of salt, left by the evaporation of the sea-water, which periodically inundates the low ground. This salt in its impure state is employed as a condiment by most of the natives and naturalized inhabitants of the neighbourhood. Without drawing any very general or sweeping conclusions, from the fact of the existence of a recent salt deposit in this situation, we cannot fail to remark, that an extensive formation is actually in the course of being produced, for the product of the disintegrated rocks, will obviously be spread successively over each saline residuum, and as each new bed is laid, the subtrata will acquire additional firmness and solidity, combined with the agency of the high mean temperature, which the most trivial observer will detect as a powerful agent in tropical countries, in binding together the most arid particles.†

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* Davy's Consolations in Travel, Dialogue vi. p. 266.

† Gemelli Careri, vol. iii. p. 36. Asiatic Society Trans. vol. iv. Sousa notices a tradition that a subterraneous passage exists between "Canari," and Cambaya, running under the sea, which was the work of Bimilamansa, who was king of all that country in the third century. Others attribute the work to the holy prince Josaphat. F. Antony de Porto, a Franciscan, is said to have travelled for seven days in this passage, without arriving at its termination. Sousa's Asia, tom. ii. 258, 395.

‡ Sonnerat Voyage aux Indes, tom. ii. c. 4.

This valley is formed by a break in the continuity of the basaltic ridge, the southern portion of which terminates here, but resumes its altitude and course near Tanna. The vale is overlooked by the hill which forms the extremity of the ridge. The ruin of a Portuguese chapel crowns its summit, consisting of the basalt, (a gray rock with augite crystals interspersed, which forms its foundation, No. 1.) At the base of the ridge near the shore is a similar ruin, built of porphyry, and at each of them there is a corresponding inscription on sandstone tablets, which must evidently have been procured from a great distance.

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* "Portugues Asia, by Manuel de Faria y Sousa, translated from the Spanish by Capt. John Stevens," Lond. 1695, 3 tomes, 8vo., tome iii. p. 14. tome ii. p. 258. The original title of the work is Asia Portuguesa, 3 tom. fol. Lisboa, 1666-75.

† Some distinguished Geologists have attributed the colour of the red sand stone to the ferruginous parts of the porphyry, from whose disintegration, they consider this formation to be derived. Humboldt Essai geognostique sur le Gisement des roches, 2nd Edit. Paris, 1826, p. 203.

The words of the inscription are contracted, and are in the Portuguese language. They relate to some individual of the name of Aquias, probably a priest, as the word *sevserdros* occurs; and the dates of the 2d of April 1620, and 28th November 1630 appear.

Near it is situated a Mahometan garden, neatly laid out in the English style, with grass walks, flower and vegetable borders, and a variety of fruit trees.

The ascent to the summit of the hill is rendered difficult, by the abruptness of the declivity and the loose fragments containing mesolite, chalcedony and quartz nodules, which readily yield to pressure, and roll to the base of the hill. The degradation of rocks cannot better be observed than in this neighbourhood, where we see them comminuting, rolling to the base and assisting in elevating the level of the vallies, and diminishing the relative height of the hills, of which a similarly striking illustration is afforded at the north-west side of the Pyrenees.* The product of this disintegration is well expressed by the German epithet, *geschiebe* the *ratchill* of the miners, and must necessarily constitute the most recent formation wherever it occurs.

From the summit of the hill the prospect is very fine, the east view being bounded by those extraordinary trap mountains whose configuration is so well expressed by their names, Funnel Hill, and the Queen of Mahratta's Castle, with the connecting ridge of the Ghauts. While, to the south, the harbour and islands of Bombay appear as if at the feet, and to the north, the dull high land terminates the prospect, the foreground being enlivened by the rich foliage of the Tamarind (Tamarindus Indica) and lofty Palmyra, (Borassus flabelliformis) and the more humble, though not less elegant jungle, consisting of the Ixora, (Ixora coccinea) Euphorbia, (E. neriifolia), and Lawsonia, (L. inermis.)

On the north-eastern side of the strait which separates Salsette from the continent, a low basaltic ridge extends for four or five miles parallel with the ridge of Salsette, and with the Ghauts, presenting, wherever the rock is uncovered, a columnar structure, and in three places, clusters of columns rise up, some of which are fifty feet high and twenty inches in diameter, the shafts being variously four or seven sided.[*]

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* Link's Travels in Portugal, 8vo. 1801, p. 64.

(*To be continued.*)

ARTICLE VII.

ANALYSES OF BOOKS.

Philosophical Transactions for 1834, Part II.

(*Continued from* p. 226.)

II. *Intensity necessary for Electrolyzation.*—In this part of the paper the author demonstrates that by producing a current by the action of sulphuric acid upon amalgamated zinc in one vessel, passing it through acid in a second vessel by platinum electrodes, a current may pass for a long period, but may be of so low an intensity, as to fall below that degree at which the elements of water unassisted by any auxiliary force capable of forming a combination with the matter of electrodes, separated from each other. He found that a solution of *sulphate of soda* can conduct a current of electricity incapable of decomposing the neutral salt present; that this salt, in a state of solution, requires a particular intensity for the separation of its elements, and that the requisite intensity is superior to that necessary for the decomposition of *iodide of potassium,* likewise in solution. Fused *chloride of lead* can also conduct a current having an intensity below that required to effect decomposition. Fused *chloride of silver* is decomposed by a similar current. A drop of water and fused nitre conducted a current without decomposition. It appears, farther, that the necessary electrolytic intensity for water, is the same whether it be pure, or rendered a better conductor by the addition of acids, for the power of acids, alkalies, salts, and other bodies in solution to increase conducting power, appears to hold good only where the electrolyte through which the current passes undergoes decomposition.

Currents of electricity produced by less than eight or ten series of voltaic elements, can be reduced to that intensity at which water can conduct them without suffering decomposition, by causing them to pass through three or four vessels, in which water shall be successively interposed between platinum surfaces.

This subject is worthy of prosecution, in order to enable us to arrange electrolytes in the order of their electrolytic intensities. In terminating this portion of his paper, the author observes, in relation to intensity generally, that when a voltaic current is produced, having a certain intensity dependant upon the strength of the chemical affinities by which that current is excited, it can decompose a particular electrolyte without relation to the quantity of electricity passed, the decomposition of the electrolyte being produced, if the intensity is too high. If this be confirmed, then we may arrange matters so that the same quantity of electricity may pass in the same time into the same decomposing body, in the same state, and yet differ in intensity, decomposing in one case, and in the other not.

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[*] Ann. of Philosophy, vii. 309.

III. *Voltaic Battery.*—From the principles laid down, it is evident that the quantity of electricity in the current cannot be increased by multiplying the quantity of metal oxidized; a single pair of plates, throwing as much electricity into the form of a current, by the oxidation of 32·5 grs. of zinc as would be produced by increasing the quantity of oxidized metal a thousand times. For the action in each cell is not to increase the quantity set in motion in any one cell, but to assist in urging that quantity forward, and in this manner, the *intensity* is increased, without affecting the *quantity*, beyond what is proportionate to the zinc oxidized in any single cell of the series. Ten pairs of amalgamated zinc and platinum plates, when acted upon by sulphuric acid, produced such a quantity of gas as to prove that just as much electricity, and no more, had passed through the series of ten pairs of plates, as had been transmitted through or would have been put in motion by any single pair, notwithstanding the consumption of ten times the quantity of zinc. All these facts tend to shew that the act of decomposition opposes a certain obstruction to the passage of the electric current, and that this opposing force is overcome in proportion to the intensity of the decomposing current. When ordinary zinc is used in a voltaic pile, the waste of power is very great, for 3½ ounces of zinc, properly oxidized, can circulate a current capable of decomposing nearly an ounce of water, and of evolving 2400 cubic inches of hydrogen. This waste, however, is greater with common zinc than with the pure metal, for, when common zinc is acted upon by dilute sulphuric acid, portions of copper, lead, cadmium, are set free on its surface, and form small but active voltaic circles, which act apparently on the zinc surface, but, in reality, upon those accidental metals. This effect is removed by employing amalgamated zinc plates, which afford the full equivalent of electricity for the oxidation of a certain quantity of zinc, but are active only when the electrodes are connected. This improvement in the voltaic battery is of great importance, for effects of deecomposition can now be obtained with ten pairs of plates, which formerly required 500 or 1000 pairs of plates. Dr. Faraday conceives that in further improving the battery, plates of platinum or silver may very likely be used instead of copper, in order to avoid the occasional solution of the copper, and its precipitation on the zinc.

IV. *Resistance of Electrolytes to Electrolytic Action.*—By interposing a platinum plate, and adding sulphuric acid to a pair of zinc and platinum plates, the current was completely stopped, by requiring it to decompose water, and evolve both its elements before it should pass. The same effect almost was produced when two pairs of plates were used, and one interposed plate. But, in the case of three pairs of plates, a current was induced which passed an interposed platinum plate, but was stopped by two. The current originated by four pairs of plates was also obstructed by two interposed platinum plates. Five pairs of zinc and platinum, with two interposed platinum plates, yielded a feeble current. Six voltaic plates, and four intervening platinum plates, induced a feeble current. The effects of retardation were altered when variety was made in the nature of the liquid employed between the plates, nitric acid appearing to increase the intensity of the current, muriatic acid transmitting a current more easily than pure sulphuric acid. Increasing the strength of the sulphuric acid caused no change in the effect.

On varying the nature of the interposed plate, it was found that with one voltaic pair and one interposed zinc plate, as powerful a current was induced as if the interposed zinc plates was absent. With two amalgamated zinc plates there was still a powerful current, but some obstruction occurred. On using three intermediate zinc plates, there was still further retardation, though a good current of electricity passed. Plates of copper seemed at first to occasion no obstruction, but after a few minutes the current almost entirely ceased.

All these retarding effects exhibit most distinctly the chemical relations and source of the current, and add to the evidence of the identity of the two.

V. *Remarks on the Voltaic Battery.*—The action of the battery is weakened by the formation during its activity of substances which may even tend to produce a counter current. In an experiment made by Faraday, the retardation of the current was obviously referable to the state of the film of fluid in contact with the zinc plate, the acid of the film being instantly neutralized by the oxide formed.

A *second* cause of diminution in the force or the voltaic battery is that extraordinary state of the surfaces of the metals described by Ritter, which causes them to oppose the passing current.

The author directs, 1st. That weak and exhausted charges should never be used at the same time with strong and fresh ones, in the different cells of a trough, or the different troughs of a battery, because, the plates in the weaker cells retard the progress of the electricity originating in the stronger cells. 2d. The associating of strong and weak pairs of plates should be avoided, as one part is apt to act as an interposing plate.

3d. Reversing tin plates, either by accident or otherwise, has an injurious effect, by opposing the current in a manner similar to interposed plates of platinum. For, in a series of four pairs of zinc and platinum plates, in dilute sulphuric acid, if one pair be reversed it almost neutralizes the power of the whole. Other causes affect the passage of the electrical current, and there is one especially of common occurrence, viz: when the copper is precipitated upon the zinc in the cells.

Dr. Davy's paper on the Torpedo *oculata and diversicolor*, termed indiscriminately by the Maltese, *Haddayla*, contains some experiments on the electricity of these species of animals, which establish the anticipation of Faraday, that by the application of Harris's electrometer to the torpedo, the evolution of heat would be observed. In his experiments detailed in a former volume of the

Transactions, it was demonstrated that the electricity of the torpedo is capable of acting like voltaic electricity in effecting chemical decompositions. He enumerates at present all the tests or indications of the electricity of the torpedo now known, which are: 1st, the philosophical effect, as the sensation it imparts is sometimes called: 2d, the chemical effects, as the precipitation of iodine, the decomposition of water, &c.: 3d, its effect on the thermometer, galvanometer, and on steel in the spiral. These tests are, in point of delicacy, in the order in which they are enumerated. Dr. Davy has been unsuccessful in his attempts to elicit a spark from the torpedo, although it has been said that a spark has been obtained from the *Gymnotus electricus*.

With regard to the seat of the electrical power, it appears that when the brain has been divided longitudinally, the fish has continued to give shocks. When the brain was completely removed the fish instantly lost this power. Humboldt stated that a shock may be procured by touching only one surface of the fish, but Davy finds that it is necessary to touch the opposite surfaces of the electrical organs, or a conductor or conductors connected with them, before a shock can be received. On some occasions a shock was received when only one surface was apparently touched, but in that case the discharge probably took place through the water, and when one surface is touched, the animal instinctively makes an effort to bring the other surface in contact with the offending body.

There appears, however, to be no connexion between the muscular and electrical power. Two views may be taken of the phenomenon. It may be considered either, 1st, a form or variety of common electricity; or 2d, a distinct kind; or 3d, not a single power, but a combination of many powers. The first opinion is supported by Dr. Faraday. The only objection to it is the interruption of the torpedinal electricity by the smallest quantity of air, and its want of the power and attraction of the air, which affords some foundation for the second idea.

The origin of the electricity of the fish may also be urged as an argument for its specific nature, but without much plausibility, because, we are ignorant of its cause and nature. The third opinion may serve as a guide for more minute investigation. The author suggests that other varieties of electricity may owe their effects to the union of several powers, or ethereal fluids, and their peculiarities to the predominance, in various degrees, of these fluids. Dr. Davy found the skin covering the electrical organs, deeper coloured and thicker than below, more vascular, with stronger muscles, and more mucus, the under surface having a greater supply of cutaneous nerves, and a blood-vessel enlarged into a little bulb, situated one on each side of the porta, below the plexus of nerves supplying the the pectoral fin, the use of which may be to propel the blood into the pectoral fin and electrical organ.

The only remaining paper connected with electricity, in this portion of the Transactions, consists of an account of experiments by Mr. Wheatstone, on the velocity and duration of electric light. In

1747 Dr. Watson found discharges through a circuit of four miles in extent, two miles through wire and two through the ground, to be apparently simultaneous. Mr. Wheatstone repeated a similar experiment, substituting for the imperfect judgment of the eye, a revolving mirror. This instrument revolved 800 times in a second, and during this time the image of a stationary point would describe 1600 circles; the elongation of a spark through half a degree, a quantity obviously visible, and equal to one inch seen at the distance of 10 feet, would therefore indicate that it exists the 1,152,000th part of a second. The deviation of half a degree between the two extreme sparks, the wire being half a mile in length, would indicate a velocity of 576,000 miles in a second. This estimation is on the supposition that the electricity passes from one end of the wire to the other: if, however, the two fluids in one theory, or the disturbances of equilibrium in the other, travel simultaneously from the two ends of the wire, the velocity measured will be half that in the former case, or 288,000 miles in a second. The greatest elongation of the sparks was 24°, indicating a duration of about the 24,000th part of a second. The general conclusions which the author draws from his experiments are, 1st, The velocity of electricity through a copper wire exceeds that of light through the planetary space. 2d, The disturbance of electric equilibrium, in a wire communicating at its extremities with two coatings of a charged jar, travels with equal velocity from the two ends of the wire, and occurs latest in the middle of the circuit. 3d, The light of electricity in a state of high tension, has a less duration than the millionth part of a second. 4th, The eye is capable of perceiving objects distinctly which are presented to it during the same small interval of time.

Physics, &c.

Mr. Hamilton's paper on a general method in Dynamics is a most elaborate one. He shews that in the method formerly employed to develope the laws of motion, the determination of the motion of a free point in space, depends on the integration of three equations, in the ordinary differentials of the second order, and the determination of the motions of a system of free points attracting or repelling one another, depends on the integration of a system of such equations, in number threefold the number of the attracting or repelling points, unless we previously diminish by unity this latter number, by considering only relative motions. Mr. Hamilton's method is to reduce the problem to the search and differentiation of a single function, which satisfies two partial differential equations of the first order, and of the second degree, and every other dynamical problem respecting the motions of any system, however numerous, is reduced, in like manner, to the study of one central function.

Mr. Ivory demonstrates that the beautiful theory of Clairaut, which assumes for the foundation of its superstructure, a mass of fluid in equilibrium, and that the pressure of every new stratum upon the surface of which it is laid, is caused solely by the forces in action at that surface, is very satisfactory when no cause of motion emanates from the fluid itself, and all the forces in action depend merely on the place of a particle, but is defective when applied to fluids consisting of particles that act upon one another by attraction or repulsion; Clairaut having omitted to attend to the attraction of the stratum, which is not infinitely little in its effect upon the motion of a particle, and is expressed by the difference of two definite integrals. The correction of Clairaut's theory is very important; because, to him belongs an essential part of the theory of the earth, and he was the first that entertained correct notions respecting the effect to alter the form of the terraqueous globe, produced by heterogeneity in its structure. In the theory of the French philosopher, the equations of the upper surface of the fluid, and of all the level surfaces underneath it, are derived from the single expression of the hydrostatic pressure, and are dependant on the differential equation of the surface.

They require, therefore, that this latter equation be determinate and explicitly given; and, accordingly, they are sufficient to solve the problem, where the forces are known algebraical expressions of the co-ordinates of the points of action, but they are not sufficient when the forces are not explicitly given, but depend as they do in the case of a homogeneous planet on the assumed figure of the fluid. In the latter case, the solution of the problem requires farther, that the equations be brought to a determinate form, by eliminating all that varies with the unknown figure of the fluid.

The author establishes a theory on the subject, applies it to the principal problems of the equilibrium of a homogeneous fluid at liberty, and demonstrates that the figure of equilibrium of a homogeneous planet can be no other than an oblate elliptical spheroid of revolution.

Mr. Barlow draws the following inferences from the results of various experiments made to determine the efficiency of paddle-wheels of steam-boats, so constructed as to make the floats enter and leave the water nearly in a vertical position, as compared with common wheels, and with relation to the consumption of fuel: 1. When the wheel is but slightly immersed, little advantage is gained by the vertically acting paddle: 2. When deeply immersed, the vertical paddle has considerable advantage over the common wheel.

3. When the position of the common wheel is vertical, it affords less resistance to the engine, and is less effective than in any pat of its revolution, which is exactly reversed in the case of the new wheel.

4. In any wheel, the larger the paddles the less is the loss of power; because, the velocity of the wheel is not required to exceed that of the vessel in so high a degree, in order to acquire the resistance necessary to propel the vessel.

5. With the same boat and the same wheel no advantage is gained by reducing the paddle so as to bring out, as it is called, the full power of the engine, the effect produced being merely to increase the speed of the wheel, and consume steam to no purpose.

6. With the same boat and the same wheel the speed will be

increased by diminishing the diameter, or by reefing the paddles, the increase of speed being in the ratio of the square roots of the radii, or the cube roots of the powers employed. This is important in long voyages, where the immersion of the paddles is great, in consequence of the quantity of coals with which steam vessels are required to be laden. An increase of speed will be given, amounting to nearly one mile per hour, by reducing the diameter of the wheel so as to allow the engine to perform its full duty.

7. An advantage would be gained by a wheel of large diameter, as far as the immersion of the paddle produced by loading the vessel is concerned, as it would not so sensibly affect the angle of inclination at which it entered the water. But, to have large wheels, it is necessary either to have the engines made with long strokes, or to have the paddle-wheel on a different shaft, in order to diminish the speed.

Anatomy and Physiology.

Sir Charles Bell, in his paper on the brain, begins by enumerating some of the impediments which have retarded the discovery of the structure and functions of that organ. 1. The nature of the inquiry, since opposite results must be expected in making investigation upon a subject so delicate. In practice, we find effects produced by causes which seem quite inadequate. The presence of a small specula of bone will sometimes be attended by no consequence, and at other times will give rise to violent convulsions. 2. The disturbance of its circulation, for no organ depends more intimately upon the condition of the circulation within it than the brain. 3. The most frequent source of error is the obscurity which hangs over the subject, for not one of the grand divisions of the brain has yet been distinguished by its function. Hence have arisen imaginary theories which always tend to bury a science in obscurity. The present inquiries of the author are directed to the prosecution of the fact discovered by himself, that the nerves of motion and sensation originate from different sources. He follows up these tracts; marks the portion of the brain to which they ultimately tend; ascertains the effect of diseases on these parts, and compares the system with the anatomical details. The consequences which he has drawn from this investigation are: 1st, that sensibility and motion belong to the cerebrum: 2d, that two columns descend from each hemisphere, one of which, the anterior, gives origin to the anterior spiral roots of the spinal nerves, and is dedicated to voluntary motion; the other sends out the posterior roots of the spinal nerves, and the sensitive root of the fifth nerve, and is the column for sensation: 3d, that the columns of motion which come from different sides of the cerebrum, join and decussate in the medulla oblongata, and that the columns of sensation also join and decussate in the medulla oblongata: 4th, that these anterior and posterior columns bear, in every circumstance, a very close resemblance to one another, agreeing in their sensorial expansions, being widely extended in their hemispheres, and in every respect, except in the nervous filaments to which they give origin.

The anatomical descriptions are illustrated by drawings, which will be found particularly serviceable in unravelling, as far as anatomy can at present carry us, some of the intricacies of the cerebral organ. The pons varolii, we observe, in an especial manner, has received much attention from the distinguished author.

The generation of Marsupial animals, which constitute a distinct tribe of mammalia, of which the kangaroo and opossum are the principal members, has hitherto been involved in much obscurity. But Mr. Owen, who has been fortunate enough to have it in his power to examine the gravid uterus of a kangaroo, has observed some important facts. The genera of this tribe are characterized by possessing a double uterus, and the true vagina is separated either wholly, or for a considerable extent, into lateral canals, while the digestive and generative tubes both terminate within a common cloacal outlet. In these respects, therefore, they approach the oviparous vertebrata. The fœtus examined by the author was contained in the left uterus. No placental structure could be observed. The chorion was very thin. A transparent amnios enveloped this fœtus. The umbilical chord was two inches in length; the uterus two inches in length, and above an inch in diameter. No perceptible trace of an allantois or urinary bladder could be detected; but in another fœtus two weeks old, a urachus was detected. The author concludes from the observations of others, coupled with his own, that the ovulum quits the ovisac as in ordinary *mammalia*. In the kangaroo uterine, gestation continues 39 days; in the opossum 26 days. The former has been determined with certainty in the Zoological Gardens, and therefore, overturns the statement of Hilaire, who made the period 4 months.

With regard to the relation between the size of the umbilical vesicle, the least vascular placenta and a corresponding simplicity of brain, it appears that in the kangaroo, although shortly after birth the brain resembles in structure that of the lowest *vertebrata*, yet it afterwards assumes a more complex form than that of the opossums or dasyures. The individuals of the marsupial tribe seem low in intelligence, never manifesting any sign of recognition of their keepers or feeders, and being unable to utter vocalized sounds. When they are irritated they emit a wheezing or snarling guttural sound, the necessary apparatus for producing vocalized sounds being absent. In this respect they resemble the *reptilia*.

In the author's communication on the *ornithorhyncus paradoxus*, this idea of similarity and that lactation might co-exist with a mode of generation essentially similar to that of the viper and salamander is fully confirmed. The regular gradation is traced which exists in different orders of mammalia, in which true viviparous or placental generation takes place, towards the ovo-viviparous or oviparous modes, in which the exterior covering of the ovum never becomes vascular. The *ornithorhyncus* is shewn to constitute a con-

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[*] The use of this term has been much reprobated by Lamarck, but notwithstanding his censure it still continues to be employed by many distinguished naturalists; and it is sufficiently expressive of a class of beings whose nature is still involved in great obscurity.—Edit.

necting link in the chain. Both of these papers are accompanied by plates.

Mr. Lister has observed the existence of currents within some zoophytes.* In the *Tubularia indivisa,* a current of particles was seen within its tube, which, in its combined and steady flow, resembled the circulation in plants of the genus *chara.* The general course of the stream was parallel to the slightly spiral lines of irregular spots on the tube. Between the stomach and the mouth a remarkable action was observed. The mouth became swollen by a flow into it from the stomach, which continued for about a minute. The contents of the mouth were then squeezed back into the stomach, and during this reflux the connecting orifice was seen distinctly open, and it continued so till the stomach became nearly empty. The orifice then closed gradually, preparatory to the effort of forcing the fluid back to the stomach. Two currents were continually going on both in the mouth and stomach, one flowing down the sides and an opposite one in the axis.

These observations were made by a microscope which magnified 100 times, and drawings were taken by a camera lucida slid over the eye piece.

In the *Sertularia pluma* Ellis, a current was observed following in the channel backwards and forwards through the main stem and lateral branches of a pluma, and might be compared to the running of sand in an hour glass, five ebbs and flows occupying 15½ minutes. When the connexion of a plume with the root was interrupted by bending its stem, the stream running down the middle was observed to continue its flow up one of the lower and stronger lateral branches, and then to return down that branch and up the main stem. The section of a stem made below the commencement of the side branches exhibited a small stream apparently followed by viscid matter. Cavolini first observed this, but no subsequent writer has noticed it. In *Sertularia pumila,* an irregular motion was noticed in the stomach and mouth, and likewise, but not distinctly, in *S setacea, dichoma,* and in species of *Campanularia.*

In a small *Ascidia* occurring on the *conferva elongata,* circulation was observed through the transparent coat, the particles of the blood not exceeding ·00025 inch in diameter. The blood enters the heart from the peduncle, the ventricle contracts in the middle and drives the fluid into the branchial organ, and into a network of vessels over the stomach and intestines. After the circulation has gone on for a while, the pulsations become fainter and gradually cease when the current is reversed. A *Polyclinum* exhibited also internal motions.

In *Cellularia* and *Flustra* none of the internal currents which in the sertulariæ connect the different parts of the zoophyte were observed, nor was any circulation detected. Each animal is enclosed in its cell, and sends out its mouth and arms through a valve. A short sheath precedes them, from whence the arms rise straight together, and then open to a funnel-shaped figure of beautiful regularity, serving probably to draw food to the mouth by currents. Between the animals of these genera no line of distinction could b detected. From these physiological observations, corrections may be brought about of the arrangement of many species. The *Serialaria lendigera* he removes from the *Sertulariæ* and the *Anguinaria anguina* from the *Tubulariæ* to the *Cellular polypi.*

In the paper of Mr. Newport, a minute detail is given of the nervous system of the *Sphynx ligustri* during the latter stages of its pupa and imago states, and on the means by which its developement is effected. During the passage of the insect from the larva to the pupa state, the gauglia and nervous cords undergo great changes both in their form and situation, and likewise in their number; and after these changes have been carried to a certain extent they are suspended for several weeks, during which the insect hybernates. At the end of this period the changes again proceed. The insect remains in the pupa state about 43 weeks, and during this period the concentration of the nervous system proceeds to a much greater extent. The author describes the double origin and connexions of the nerves distributed to the wings, the object of which appears to be, to establish a harmony of action between the wings in those insects especially, which are remarkable for velocity and power of sight, a different structure being adopted in those which fly with less regularity or speed.

A *pneumogastric* nerve or *par vagum* is described, which is distributed to the organs of digestion and respiration. The author likewise notices lateral cephalic ganglia, which may be regarded as auxiliary brains, and a sympathetic nerve; besides a set of nerves which appear to correspond with the respiratory nerves of vertebrated animals. The primary longitudinal nervous cords of insects are shown to consist of two tracts, the one situated over the other, corresponding to the two columns of which the spinal cord consists in vertebrated animals; the one forms the seat of sensation, and the other of motion. The same observation has also been made upon the lobster, *Scorpion,* and *Scolopendra,* and in several insects, as the *Gryllus viridissimus,* the *Carabus,* and *Papilio urticae.*

Such are the principal papers of which this portion of the Philosophical Transactions consist. The substance of Mr. Powell's paper, with additions, is inserted in a preceding part of this Journal. It is rather remarkable, that with the exception of a short notice of a mineral water, there is no purely chemical paper contained in it.

Article VIII.

SCIENTIFIC INTELLIGENCE.

I.—*Employment of Gypsum in Agriculture.*

Gypsum has been employed in Switzerland, Germany, England, and North America for many years as a manure, but it was only brought into use in France about forty years ago. At present it is very generally used in that country, with the exception of the departments of Gard and Herault. (*Ann. des Mines,* vi, 193.)

For the purposes of agriculture it is sometimes calcined, which deprives it of its water of crystallization, which in the hydrous gypsum amounts to 2 atoms. This preparation is attended to in France, where the expense of the process is less than in other countries. In England, Germany, &c. it is generally employed in the crude state. The effect which calcination produces, is to render the gypsum more rapid in its operation, though the beneficial effects are less durable. In France it is burned in a kind of lime kiln by means of coal, after being reduced to powder.

It can be obtained in this state in Gard, for one shilling the 110 lbs. avoird., and it costs double the expense in Alais. Extensive natural deposits occur in England in the neighbourhood of the Humber, from whence it is brought to Glasgow and Manchester for the use of the bleachers, who now employ it in considerable quantities. Its purity may be negatively tested by vinegar, which, if it causes no effervescence, shews that there is no carbonate of lime present. If it swells up when water is thrown on it, and then assumes consistence, it is a sign that it has been properly calcined. The best plaster will absorb the greatest quantity of water. It is chiefly on artificial meadows that we observe the best effects from its application, more especially on clover, lucern, sainfoin, and in general on the leguminous tribe of plants possessing large and thick leaves. It has a powerful effect also upon natural meadows which contain much clover, vetches, and other analogous plants; but upon the grasses the effect of gypsum is trifling. It acts, according to M. Thibaud, by extracting the moisture from the air, and stimulating the vital action of plants.

It sometimes doubles the product of clover, lucern, and sainfoin. In France it is sowed like corn with the hand, about March or April when the plants are a few inches above the soil, so as to allow the gypsum to fall on the leaves. It should be done previous to rain, but not during the fall of rain, or the existence of wind, or during frost.

The quantity of gypsum applied to the land must vary of course with the nature of the soil. In the course of fifteen or twenty days the good effects resulting from its use are visible, if circumstances have been favourable. The benefits of one application last for two or three years, so that it is unnecessary to spread it every year. In Gard and Herault sainfoin is principally cultivated for pasture, and seems to thrive well in dry soils, especially in stony calcareous situations. About Alais, for the cultivation of this plant in artificial meadows, the ground is first plowed in November, then again in December, and the seed is sown in the beginning of April.

In Provence and in the southern parts of Languedoc, where the effects of frost are less dreaded, it is sown in Autumn. The sainfoin thus cultivated in inferior soil affords one or two crops in the year, and lasts for four or six years; then it is plowed up and corn is substituted for it. It is worthy of remark, that lands which previously could not produce corn, has, by the use of gypsum in the manner described, been able to raise good crops in the midland parts of France. The agriculturists of Alais may procure gypsum from Anduze, Salle, Rochebelle, and Blanaves. To Drome it may be carried from Gard and Ardeche. At Herault it may be obtained at Cruzy, Quarante, Calzouls, Herepian, Beziers, Clermont, Loubes, and Lodeve. It is extensively employed in Canada with the most happy results. It was tried in Yorkshire by Lord Dundas without any benefit, but the soil upon which it was spread was ascertained to contain a quantity of gypsum. It might be employed, there can be little doubt, with great advantage in the border counties, where the *trifolium pratense* has in many places failed. This plant necessarily from its strong and luxuriant nature, obviously must require a considerable quantity of the manure. If it be deficient in quantity the plants may vegetate, but must speedily perish from the effect of the first frost on their delicate structures.

II.—*Royal Institution.—Comparison of the Newtonian and Undulatory Theories of Light.—30th January.*

Dr. Ritchie commenced his lecture on the two theories of light which have been advocated by different philosophers for many years, with a few observations with regard to the difficulty of acquiring knowledge of the subject by direct experiment, in consequence of the almost spiritual nature of the substance upon which it is necessary to operate.

Newton whose opinion was long in vogue, having had his attention directed to the motions of bodies, considered light as a substance consisting of revolving spherical particles issuing from luminous bodies moving in straight lines, and producing reflection or refraction according as the extremities of the spheres, which came in contact with a denser medium, were sharp or obtuse. This theory required certain postulates which appear, however, to be entirely gratuitous. By the undulatory theory, which is often called the theory of Huygens, which was suggested to his mind in consequence of his attention being directed to the motions of the pendulum, although it was known before his time, light is considered to consist of the undulations of an ethereal fluid filling all space, and existing between the particles of bodies. If such a fluid does exist, we might expect that it would act in retarding the motions of the heavenly bodies. It is obvious, however, that the planets can suffer no retardation, because, in consequence of their revolutions, the ether will also acquire motion and be carried along with them, but in reference to the comets, which are extremely light bodies, we find a decided retardation, which after making all allowances, can only be accounted for on the supposition of the existence of an etherial medium. This has been clearly proved by Sir John Herschel, in his article on light in the Encyclopædia Metropolitana. Dr. Ritchie stated that he had only become a convert to the undulatory theory of light about two years ago, in consequence of Herschel's arguments, and an attentive comparison of the two theories. This ether, then, is supposed to exist in the pores of all bodies, being more dense in solid bodies than in empty space, but possessing less elasticity. An impulse being given it, a succession of waves is produced, precisely like sonorous vibrations which strike upon the retina and cause that membrane to move backwards and forwards, or vibrate, as the undulatory motions of the air, excited by sonorous bodies, occasions motions in the membrana tympani. These vibrations follow in regular succession, and according as they are more or less frequent or rapid in succession, the sensation of colour is produced.

The following table exhibits the number of vibrations which are distinguishable in a second, and the length of a wave:

Number of vibrations,	Leugth of a wave.
32	32
64	16
128	8
4096	3 inches.
8192	1½

The number of vibrations which produce the different colours of the spectrum has been calculated with wonderful precision:

Red	458,000,000,000,000.	
Orange	506	,,
Yellow	635	,
Green	577	,,
Blue	622	,,
Indigo	658	,,
Violet	727	,,

The length of a wave is ·0000266 inch, from which we can calculate the vibrations.

These numbers are so enormous that one is apt to be sceptical as to their accuracy. Their computation is, however, extremely easy, and we are perfectly certain that they form very close approximations to the truth.

By screwing two plates of glass together, the rays of light pass through the first, and are refracted by the second, and when received on white paper, exhibit the fits of Newton, consisting of alternate light and dark colours. A happy idea struck Dr. Ritchie on the morning previous to his lecture, that by a modification of this principle, Newton's rings might be exhibited. He accordingly screwed together two plates of glass, divided at their margins merely by a layer of gold leaf, directing the pressure upon one central point with the extremity of the screw, around which were beautifully displayed the rings as he had anticipated. These may be enlarged by additional pressure near their circumference. In this way these can be measured, and the above numbers deduced. Frenelle, by means of ingenious apparatus, has been enabled to exhibit the length of the waves, and measure them by means of a microscope. His results were the same as those given. Dr. Ritchie considers that the experiments of Frenelle prove conclusively that light consists of the undulations of a fluid, interfering with each other and producing darkness.

A further proof in favour of the theory is, that when light is passed through a small aperture, by reflexion, we have, if we place a sheet of paper opposite to the hole, alternations of red and dark colours, and M. Arago has shewn that light moves more slowly through glass than air. M. Colladon, by some very interesting experiments at the lake of Geneva, has proved that with sound as with light, the angle of incidence is equal to the angle of reflexion. Newton objected that if light, like sound, consisted of waves, sound ought to have a shadow. Now, the fact is, that when sound passes very rapidly we have a kind of shadow of sound. When two tuning forks are set differently, we have one sound ascending and the other descending, affording a strong similarity to the interference of undulations. When light is polarized, as by Iceland spar, if we cause two portions to act upon the same plane, alternations of dark and light colours are obtained, shewing interference of waves, but when these portions act at right angles no such interference takes place. When light passes through a gas, and when we examine the spectrum, we observe dark spaces, which may be occasioned by one wave interfering with another. Light from the sun does not possess polarized properties which light from a hot iron does, shewing that light is derived from the sun's atmosphere, and not from the substance of that luminary, because, in the latter case, there would be a gradual diminution of its size. A strong argument in favour of the undulatory theory is derived from a recent experiment of Mr. Faraday, who found, by the action of electricity, that as much light was given out from a copper wire in the course of a few days as could be emitted from the sun in a year. Is it possible to suppose that this enormous quantity of light existed pent up in a substantial form in the wire? Dr. Ritchie gives his decided negative to such an opinion, but is inclined to infer that the light which enables us to see exists within ourselves, as the heat which warms us is contained within us.

6th February.—Dr. Faraday exhibited some very beautiful experiments illustrative of his new researches in electricity, an account of which was read the previous night at the meeting of the Royal Society. They referred to the phenomena of induction, which constitute the facts from which Dr. Faraday has raised a new branch of science. He shewed that the electric spark and shock may be obtained by means of a helix connected with a voltaic pile and a long train of wire, leading into a bason of mercury, the instant that the current is broken; proving that the effect is produced by the agency of the induced current. The same phenomena do not occur when short wires are employed. He exhibited likewise the electro-magnetic-machine, in which the electricity developed in a coil of wire is beautifully elicited by means of a magnet rotating in contact with mercury. This instrument forms an excellent means for procuring an instantaneous light, as the spark is capable of igniting combustible bodies, as candles, lamps, &c. We shall take the earliest opportunity of presenting our readers with an analysis of Dr. Faraday's papers.

13th February.—Mr. Landseer read a very learned disquisition on a monument, of which a cast was brought to this country by Mr. Joseph Benomi, who has recently published travels in the East. The original of this ancient relic exists along with nine others on the sea shore near the river Lycus, two hours journey from Bayrroot. With the exception of this one of which the cast was exhibited to the meeting, by permission of Lord Prudhoe, the monuments are much defaced.

They were probably seen by Herodotus, for he describes similar relics in Ionia. Maundrell saw them in 1767, and describes them with great accuracy. Benomi is the only other modern traveller who has been fortunate enough to fall in with them. He, in the most praiseworthy manner, undertook the labour of making a cast of the most perfect one, instead of carrying off the original in the way too often practised by eastern visitors.

It appears to relate to Sesostris or Rameses II., who lived, according to Dr. Pritchard, 1007 years from the commencement of the Egyptian era. The principal feature in it is the figure of a monarch, with a sceptre in one hand, and a dove in the other, of which, however, only the tail remains. The dove was the standard of the Assyrians, hence, in the Bible it is represented as an oppressor. Over the dove are 7 orbs, which are the seven stars the pleiades, the Succoth-penneth, or tents of the daughters in Scripture, called genial and exhilirating stars, and are shedding their influence over the dove.

The face of the monarch is towards the east, and the stars are placed on the east of the monument, rising with Aldebaran. Two larger orbs represent the sun and moon, supplied with wings similar to the sculptures of Persepolis. There is still another star which is probably Venus, the morning star. Mr. Landseer from these and similar data, concludes that this monument was sculptured in the time of Pelassar or Salmanassar, twenty-five centuries ago. Another monument of which a drawing by Benomi was exhibited, contains on its margin the hieroglyphical name of Sesostris, identical with that which exists on the table of Abydos. The sculpture represents the figure of a man holding a bow in his right hand and a battle-axe in his left, in the act of offering prisoners to a deity. Herodotus describes an Ionian monument almost identical with this. Another of the monuments observed near Sidon, relates the circumstance of Antoninus having altered the road along the coast, the former road having been at a greater elevation.

In the course of his lecture Mr. Landseer displayed an intimate acquaintance with sacred and profane history, and shewed that his mind was keenly alive to the refinements of literature. In some of the poetic flights in which he frequently indulged, we were brought back to those ancient times, when the kindly influences of the heavenly orbs presided over human destinies, and the descriptions might have almost induced the sanguine to regret, that such mysterious days have passed away.

III.—*Pharmaceutical Preparations.*

1. *Antacid Lozenges.*—This preparation may be made as follows:—Take 33 oz. 3½ dr. of pounded sugar; Sesquicarbonate of soda, 1 oz. 7½ dr.; Mucilage of gum-arabic, 5½ oz. Mix the sugar and the sesquicarbonate in a mortar, add the mucilage, which may be mixed with a little conserve of roses, oil of peppermint, or orange-flower water, and form the mass into a paste, which may be divided into oval lozenges, weighing about 14¾ grains. Each will contain about $\frac{8}{10}$ of a grain of sesquicarbonate of soda. (*Journ. de Chim. Med.* i. 66.)

2. *Chloride of Zinc.*—Professor Hanké of Breslaw has employed salt successfully as a caustic in *fungus hematodes, malignant pustules, neviæ and syphilitic ulcers with a carcinomatous appearance.* He prefers it to corrosive sublimate, red precipitate, nitrate

of silver, or arsenic. The latter he thinks ought never to be used. M. Canquoin recommends its application in cancerous diseases, in the form of a paste, consisting of two to four parts of flour, to one of chloride of zinc, brought to the proper consistence by means of water.

Muhrbeck has employed it with success internally, to the extent of from $\frac{1}{12}$ to $1\frac{1}{2}$ gr. for the cure of periodical headache. Hanké has also used it in chorea tic douloureux, epilepsy, dissolved in muriatic ether, (1 gr. chloride, 6 scs. ether) beginning with five drops every four hours. When taken in over-doses it produces nausea, vomiting, cold sweats, convulsions. It may be prepared by distilling one part of zinc with four parts of corrosive sublimate, or by evaporating to dryness a solution of zinc in muriatic acid. These differ in some respect, for the first, called, *butter of zinc,* is volatile, while the other is only so at a red heat. *(Journ. de Chim. Med.* i. 77.*)*

3. *Mercurial Ointment.*—M. Langlois, according to the suggestion of Chevallier, recommends the following process for making this ointment: He introduced $1\frac{1}{4}$ lb. troy into a glass bottle, and poured upon it $7\frac{4}{5}$ oz. of melted fat. He then placed the stopper in the bottle, and agitated the mixture until it became cold. It was then placed in warm water, and again liquified. While still soft, the mixture was poured into a marble mortar previously heated with warm water in order to retard the cooling. It was then triturated briskly for three quarters of an hour. No globules could then be observed. The same quantity of fat was added as at first, and the whole was triturated for an hour. The preparation of the ointment was now completed. *(Journ. de Chim. Med.* i. 125.*)*

IV.—*Muriate of Ammonia in some Minerals.*

M. Vogel of Munich has found, 1. That muriate of ammonia exists in the oxide of iron from Bohemia, but those oxides which he examined that were brought from Bavaria, at a distance from volcanoes, contained none.

2. That the common salt of Frederickshall, in Wirtemberg; the rock salt of Hall, in Tyroll, as well as the different salts of all the countries of Bavaria, contain, like volcanic products, muriate of ammonia.

3. That the water of saline springs does not appear to contain sensible traces of muriate of ammonia, *(Jounal de Pharm.* xx. 501.)

V.—*Peroxide of Manganese.*

Vogel of Munich has found organic matter in this mineral, as well as in amphibole, nepheline, asbestus, adhesive state of Menilmontant, felspar, and flexible sandstone of Brazil. He detects the organic matter by boiling the mineral with distilled water, decanting without filtering, and exposing the liquid to the sun mixed with a few drops of nitrate of silver; if organic matter is present a red wine colour will be produced. The presence of this matter in the peroxide of manganese accounts for the carbonic acid which comes over in the preparation of oxygen. The muriatic acid which is sometimes observed when oxygen is obtained from this mineral by sulphuric acid, is derived from the latter, as Mr. Kane had shewn. *(Journ. de Pharm.* xx. 502.*)*

Meteorological Journal,

Kept at the Manse of the Parish of Abbey St. Bathan's, Berwickshire, Lat. 55° 52′ N. Long. 2° 23′ W. at the height of about 450 feet above the sea. By the Rev. John Wallace.

FEBRUARY.

DATE.		THERMOMETER.				HYGROMETER (Leslie's.)				BAROMETER. At 32° of Fahrenheit.				Rain in Inches. Weekly.	Prevailing Winds.	REMARKS.
1835.		IX. A.M. °	X. A.M. °	III. P.M. °	X. P.M. °	IX. AM °	X. AM °	III. PM °	X PM °	IX. A.M.	X. A.M.	III P.M.	X. P.M.			
Su.	1	45½	48	49	49¾	5	5	8	7	29·393	29·391	29·382	29·298	·270	W. of S.	Overcast with drizzly clouds, strong boisterous wind.
Mo.	2	46½	49	44	45¼	4	10	13	7	29·281	29·294	29·481	29·496		S. Wy.	Partially clear, evening cloudy, with brisk wind and slight showers.
Tu.	3	49¾	50¼	50	47½	10	12	14	13	29·571	29·590	29·565	29·675		S. Wy.	Overcast, brisk gale.
We.	4	47¾	47½	48¾	43½	9½	11	18	5	29·717	29·743	29·751	29·669		S. Wy.	Clear, 3 P.M. cirri to the south, brisk gale, evening calm below, but light clouds above in rapid motion.
Th.	5	45¾	43¼	39	33¾	13	11	13	11	29·158	29·149	29·137	29·159		N. Wy.	Wind boisterous, sudden showers, P.M. snow, change of wind, evening clear.
Fr.	6	34½	35¼	37¾	39¼	9	10½	13	7	29·499	29·551	29·602	29·465		W. of N.	A.M. brisk wind, ribbed cirrostratus, P.M. cloudy and calm, cirrocumulus with cirrostratus.
Sa.	7	47¼	48	50	38½	13	15½	16	12	29·176	29·141	28·930	28·821		Wy.	Brisk wind, evening bright aurora borealis, slight showers
Su.	8	35¼	37	36¼	32	7	11	8	7	28·802	28·781	28·665	28·891	·188	Wy.	Boisterous wind with occasional showers of snow, evening clear and calm.
Mo.	9	31	33¾	35¼	30¼	6½	14	6	9	29·215	29·216	29·160	29·390		Ny.	A.M. clear and frosty with a gentle breeze, evening boisterous with snow showers
Tu.	10	30¾	33	34	33½	9	9	12	12	29·747	29·772	29·706	29·670		N. Wy.	Clear with light wind, frosty, evening cloudy.
We.	11	44	44	48¾	46½	9	7	11	12	29·657	29·607	29·480	29·414		N. Wy.	Brisk wind with tendency to rain, evening, sky overspread with fleecy clouds.
Th.	12	39	41	42½	36½	15	16	16	8	29·536	29·553	29·567	29·633		Wy.	A.M. fine, calm and clear, P.M. gentle breeze with light clouds, evening clear brisk wind.
Full M. Fr.	13	38	40	42	35	11	13	14	4	29·649	29·654	29·611	29·593		Wy.	Calm, A.M. clear, P.M. lightly cloudy, evening slightly overcast
Sa.	14	42½	46	49	44	5	7	14	11	29·328	29·271	29·210	29·173		Wy.	A.M. calm, tendency to rain, Noon partially clear, gentle wind, evening, rain.
Su.	15	43¾	45¾	44½	36	11	16	13	5	28·909	28·890	28·754	28·876	·484	Wy.	Partially cloudy with light flying showers, evening, rainy, 10 P.M. cloudless.
Mo.	16	40½	41½	43	37½	3	3	8	5	29·070	29·067	29·070	29·031		Shifting.	A.M. drizzling rain with wind eastward of north.
Tu.	17	36¼	38½	42¾	37¼	8	10	12	9	29·094	29·090	28·983	28·844		S. Wy.	Fine, gentle breeze, white floating clouds evening cloudy with brisk wind.
We.	18	36½	38¼	38¼	30½	7	11	17	6	28·653	28·672	28·737	29·714		S. Wy.	A.M. showery, P.M. brisk wind and floating clouds, evening clear and frosty.
Th.	19	30½	32	34¾	32½	5	0	5	7	28·629	28·641	28·555	28·211		S. Wy.	Light breeze, partially cloudy, 10 P.M. slight snow.
Fr.	20	33½	35	38	30	5	9	10	11	28·340	28·350	28·421	28·450		Wy.	A.M. slightly overcast with showers of snow, P.M. clear, evening light wind.
Sa.	21	33¼	37½	38	35	2	7	10	5	28·482	28·477	28·561	28·576		Wy.	Gentle wind with fleecy clouds, evening clear with brisk wind.
Su.	22	36¾	38¼	40¾	33	9	8½	10	4	28·950	28·961	28·853	28·240	1.750	Sy.	A.M. clear, P.M. overcast, evening rain and soft snow, wind tending to S. E.
Mo.	23	41	40½	42½	36½	9	8	17	9	27·929	27·997	28·387	28·760		Wy.	Boisterous wind with occasional showers.
Tu.	24	37	39½	40	32½	10	12	15	6	29·025	29·053	29·102	29·087		Wy.	Gentle breeze, A.M. cirri, P.M. clear and frosty, evening calm, sky obscured.
We.	25	44	46	43¾	37	3	3	7	10½	28·465	28·436	28·375	28·466		S. Wy.	Brisk wind with rain, evening calm and clear.
Th.	26	37½	38¾	41	36	5	4	18	10½	28·401	28·420	28·487	28·442		S. Wy.	Brisk wind, partially clear with floating cumuli, evening calm and cloudy.
New M. Fr.	27	33	35	36	35	6	3	9	13	28·336	28·342	28·376	28·694		N. Ey.	A fall of snow with gentle breeze, evening fair, sky obscured, sudden gusts.
Sa.	28	36	37¼	36	27¼	7	9½	12	1½	29·123	29·166	29·197	29·077		N. Wy.	Partially clear, cirri, sometimes nearly cloudless, calm, evening frosty.
Means.		39·2	40·7	41·6	36·8	7·3	9·1	12·1	8·1	29·041	29·045	29·039	29·033	2·692		Means for the Month. Thermometer 39¼ Hygrometer 9·15 Barometer 29·039 Moisture in a cubic inch of air = ·00138 grains. Mean point of deposition for February, 32°·2.

RECORDS

OF

GENERAL SCIENCE.

MAY, 1835.

ARTICLE I.

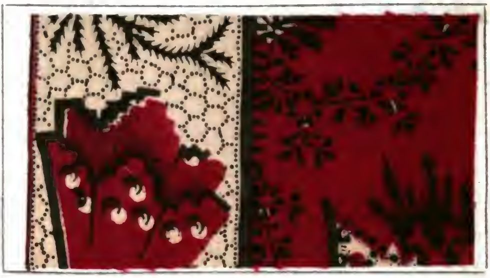
On Calico-Printing. By THOMAS THOMSON, M.D., F.R.S., L. and E., &c., Regius Professor of Chemistry in the University of Glasgow.

(*continued from* p. 173.)

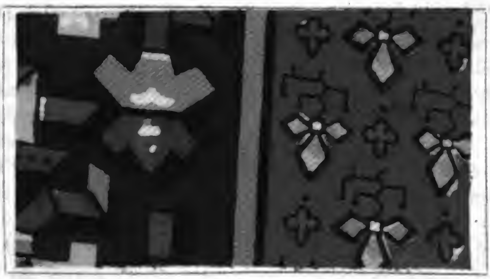
IN the paper on Calico-Printing inserted in the third number of this Journal, I gave an account of the mode employed, to prevent the fixing of the dye on particular parts of the cloth, or of discharging it after it has been fixed. At present, I mean to explain the methods practised in the application of *chemical colours* to calicoes.

The term *chemical* seems originally to have been applied to certain colours, which were prepared by means of substances brought directly from the laboratory of the chemist, as distinguished from those made of materials previously in common use. They consist principally of solutions of tin, mixed with decoctions of the various dyewoods; and, as the colouring matter of these woods is readily acted on by the *light*, as well as by alkalies and acids, *chemical colours* came to be understood as necessarily fugitive colours. Chemical blue also, (a solution of Prussian blue in muriatic acid, or perchloride of tin,) and various other topical applications are of the same class. But the fugitive character of these colours is to be attributed rather to the unstable nature of the colouring materials, than to the manner of their application. Could the colouring matter of madder, for example, be produced pure and unchanged in a state of solution, there is little doubt that the chemical which might be obtained from it would be a permanent colour. A state of solution more or less complete is necessary to the adhesion of these chemical colours to cloth.

1. *Chemical Black.*



This colour is produced in a variety of ways. Some years ago it was almost universally a decoction of nutgalls, to which, after it became cold, nitrated peroxide of iron was added, previously thickened with flour. A paste was thus produced, of a slate colour, which being printed on the cloth and afterwards exposed to the air, became black. Now it is considered better to use a salt of the protoxide of iron, which, after being printed on the cloth, is exposed to the air. The iron is gradually peroxidized, and the colour becomes black. In a dry atmosphere, several days exposure to the air are necessary to peroxidize the iron completely. The black compound is then insoluble in water, and when the cloth is washed, nothing is removed except the thickening matter, and other superfluous matters which are not combined with the fibres of the cotton. A chemical black is also produced by mixing a decoction of logwood with a protosalt of iron; but it is not so permanent as the gall black.



The portion of calico here presented to the reader exhibits specimens of no fewer than four different chemical colours: namely, pink, blue, green and orange. I shall endeavour to explain how these different colours are obtained.

2. *Chemical Pink.*—This beautiful colour is produced either from *Brazil* or *peachwood.* A decoction is formed of these woods, which is thickened with gum-senegal, and afterwards mixed with perchloride of tin. The salt precipitates the colouring matter in the state of a lake, which is re-dissolved by an excess of the salt of tin. In this state of solution it is applied to the cloth, which in the course of a few hours decomposes it, and when the cloth is washed, the lake remains attached to it.

3. *Steam Blue.*—It is known that when hydro-ferrocyanic acid is boiled in water, hydro-cyanic acid is evolved, and a white powder precipitates which becomes Prussian-blue by exposure to the atmosphere. It is in this way that what is called *steam-blue* is produced. Crystallized prussiate *of potash* is dissolved in water, and mixed with tartaric acid. Bitartrate of potash or *cream of tartar* precipitates, and the remaining liquid consists partly of hydro-cyanic acid dissolved in water; but it contains also the white *Prussian-blue,* if such an expression may be permitted. This liquid is thickened with gum and printed on the cloth.

Or sometimes gum-senegal is dissolved in aqueous prussiate of potash, and an equivalent of sulphuric acid added.

The print is now exposed to the steam of boiling water, and the blue *raised** (if the other colours will allow) in a weak solution of chloride of lime *(bleaching powder,)* or of bichromate of potash. Should such a process be incompatible with the other colours, the cloth is merely exposed to the air for a considerable time, by which the blue becomes almost as deep as when chloride of lime is employed.

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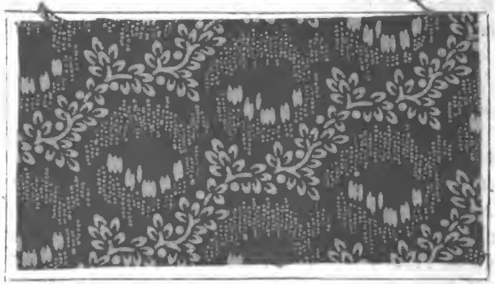
* The technical term for increasing the intensity of a colour.

4. *Steam-Green.*—This colour is, in fact, a combination of the preceding, with a yellow colour, produced by a decoction of Persian berries, and fixed on the cloth by alum. The precipitate of potash is dissolved in water, and this liquid is mixed with a decoction of Persian berries and alum. These substances have no sensible action on each other while cold. But on the application of steam after printing, the acid of the alum becomes united with the potash, while the alumina combines with the yellow colouring matter of the Persian berries, and fixes it on the cloth. At the same time the heat causes the deposition of the white Prussian-blue, which gradually assumes a blue colour by exposure to the air. The blue and yellow colours united are well known to produce a green.

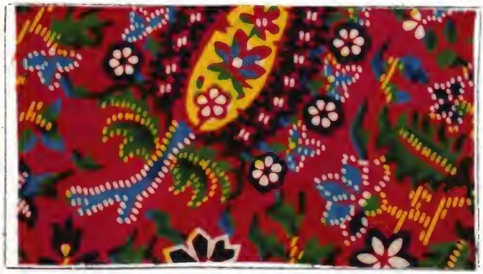
5. *Annatto Orange.*—Annatto is dissolved in potash or soda, and printed on the cloth. This constitutes the whole process.

6. *Chrome Yellow upon Turkey-Red.*



This is produced by a modification of the patent process described in a former part of this article. Tartaric acid and nitrate of lead are dissolved together in water, which is thickened with gum, and printed on those parts of the Turkey-red cloth that are to become yellow. When the cloth is passed through a solution of bleaching powder, those parts of it on which the tartaric acid had been deposited, are deprived of their colour, while at the same time the oxide of lead detaches itself from its acid and becomes fixed upon the cloth. The cloth, after being washed in water, is passed through a solution of bichromate of potash, which converts the oxide of lead into chromate, and thus communicates the beautiful and permanent yellow colour.

7. *Blue and Black upon Turkey-Red.*



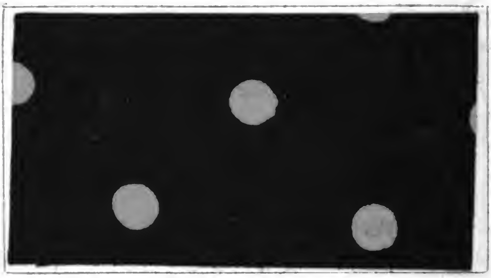
The mode of discharging the colour from Turkey-red cloth has been already explained, and also the mode of impregnating the white spots thus formed with chrome yellow. At present we shall endeavour to explain how the black, the blue, and the green, which add so much to the beauty of the calico here presented to the reader, are induced.

To obtain the black a perchloride of iron is prepared, by dissolving carbonate of iron in muriatic acid. This solution is afterwards employed for dissolving Prussian-blue, which it does very well, provided the blue be ground into a fine powder. The solution is afterwards diluted with water, and brought to the proper consistency by mixing it up with starch, and keeping it for some time at the temperature of 200°. The paste thus made, when cooled down is fit for use. It is applied to or printed on the cloth at the same time with the blue, and with the acid which is to produce the white observable on a portion of the cloth. The cloth being passed through a solution of chloride of lime, the free lime precipitates oxide of iron upon the Prussian-blue, which assumes a black colour, because it has been superinduced upon the red.

The Prussian-blue, to induce the blue colour so conspicuous in the calico, is dissolved in perchloride of tin, which is prepared by passing a current of chlorine gas through a solution of protochloride of tin. The solution is then diluted with water, in which tartaric acid is dissolved, in the proportion of 4 lbs. to the gallon, and afterwards thickened with starch or British gum. It is then ready for use. When cloth on which this paste has been printed is passed through the vat containing a solution of chloride of lime, the oxide of tin is precipitated by the action of the free lime upon the perchloride, and fixes the blue on the cloth; while, at the same time, the tartaric acid, by disengaging chlorine from the chloride of lime, destroys the red colour of the cloth. Hence, the blue shows, as blue always does when deposited on a white ground.

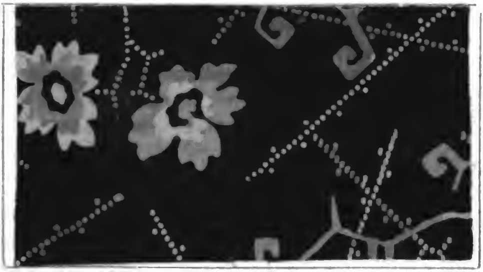
The yellow portions of the calico had been rendered white in the way formerly described. The yellow was afterwards induced by a decoction of Persian berries. When this yellow die was deposited over the blue it formed the green so conspicuous in the calico, and adding so much to its beauty.

8. *Chrome Yellow on Indigo Blue.*



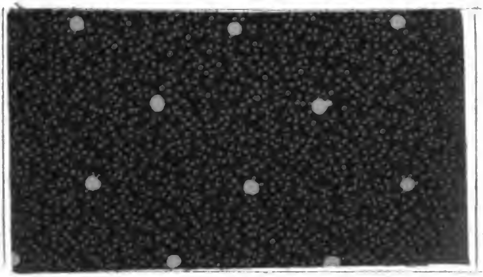
The mode of obtaining a white upon dark-blue has been already described. To form a paste which shall at the same time resist the blue vat and leave a mordant for yellow, a solution of nitrate and acetate of lead, with nitrate and acetate of copper, is formed and brought to the requisite consistence with gum and pipeclay. While the indigo is depositing itself upon the cloth, the lime which holds it in solution is precipitating the oxide of lead on those parts of the cloth to which the paste had been applied. After being washed in water, the cloth is passed through a solution of bichromate of potash. Those parts only become yellow upon which the oxide of lead has been fixed. But the colour is at first pale and dirty, from the presence of a quantity of oxide of copper deposited at the same time with the oxide of lead. To remove the copper and heighten the yellow, the cloth is immersed in a weak solution of muriatic acid in water.

9. *Orange and Yellow upon Blue.*



The process in this case is the same as in the last, only the cloth, instead of being passed through a hot solution of bichromate of potash, is passed through dichromate of potash. Two atoms of oxide of lead combine with one atom of chromic acid and thus produce the orange. When weak nitric acid thickened with gum is printed upon portions of this orange, half of the oxide of lead is removed, and the orange is immediately converted into yellow.

10. *Chrome Yellow upon Bronze.*

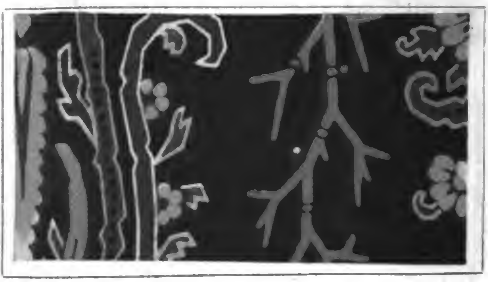


Sulphate of lead is mixed with chloride of tin, and printed upon bronzed cloth. A double decomposition takes place, and chloride of manganese with peroxide of tin is formed. When the cloth is washed in water the chloride of manganese dissolves and is carried away, but the tin remains adhering to the cloth, and along with it the sulphate of lead. This salt is afterwards decomposed by lime, and the oxide of lead adheres to the cloth, and becomes yellow when the cloth passes through a solution of bichromate of potash.

Instead of sulphate of lead, other substances may be deposited in a similar manner. The pale chromate of lead, for example, may be mixed with protochloride of tin, and remain so for some hours without material injury. A yellow is thus produced without the necessity of any subsequent operation. The lake from Brazil wood or cochineal may also be employed to produce a pink discharge upon bronze, that of logwood a purple, &c. But prints formed in this way cannot be washed, even in cold water, with any degree of freedom.

Red oxide of iron is permanently fixed upon bronzed cloth, as may be seen in the specimen of cloth marked No. 9, by printing a solution of protochloride of iron on the parts of the cloth that are to undergo the alteration. In a few hours the manganese and iron change places, the iron being deposited on the cloth in the state of peroxide, while the chloride of manganese is removed by washing.

11. *Red and Chocolate Resist on Pale Blue.*

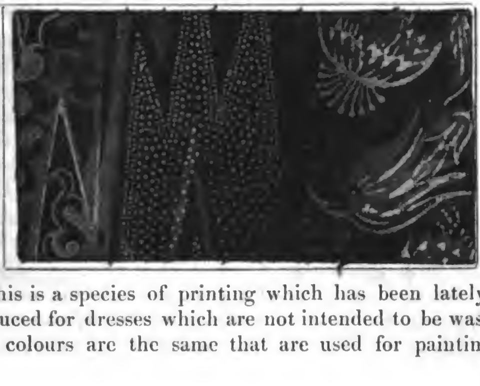


If the aluminous mordant, with the addition of a little verdigris and soft soap, and thickened with gum and pipe-clay, be printed upon white cloth, the piece may be immersed in the blue vat without any of the indigo attaching itself to the parts of the cloth so printed. If the piece of cloth be then dunged and dyed in the usual way, a red is produced on a pale blue ground. The same mordant, with the addition of acetate of iron, gives a chocolate colour.

Let us now explain how the white portion in the specimen of printed cloth before us has been preserved from the dye. A preparation called *neutral paste* is employed in this style of work, to defend the cloth against both the red and chocolate and the blue. It is a mixture of *lime-juice* and sulphate of copper. If this mixture remains upon the cloth longer than a few days, a portion of the oxide of copper attaches itself so firmly to the cloth that no washing is capable of removing it. And this portion of copper attracts a portion of the madder in dyeing, and tinges the part of the cloth intended to be white, of a pale brownish red.

In the specimen before us, all that is now bronze, yellow and pink, was originally printed with the white; the three colours given by catechu, Persian berries, and Brazil pink, being a subsequent application. The green is the result of berry-yellow on the blue, and the orange of the same colour on the pink.

12. *Pigment Printing.*



This is a species of printing which has been lately introduced for dresses which are not intended to be washed. The colours are the same that are used for painting or printing on paper; and being body colours, which conceal what is beneath them, they are used for black and various other coloured grounds. A brilliant effect is thus produced at small expense.

Article II.

Sketch of the Geology of the Bombay Islands. By Robert D. Thomson, M. D.

(Continued from p. 304.*)*

ELEPHANTA ISLAND.

The form which this island presents at a distance is somewhat pyramidal, but on a nearer approach it is found to consist of two distinct hills, with an intervening valley. This vale is profusely studded with trees and bushes, as well as the hills, which are clothed with wood from the water's edge to the summits. Many of the trees are tall and stately, as the brab or palmyra, while others are covered with the densest foliage, as the tamarind, with its rich green leaves and elegant blossoms. In the dry season the island exhibits the best appearance from the summits of the hills, or by approaching it from the sea, for at that time the earth is dry, parched, and as if baked, being crossed in every direction with fissures, which greedily suck up tbe rain whenever it happens to fall, and, of course, is destitute of that rich vegetable carpet which covers it during the prevalence of the monsoon. Then the soil is one mass of verdure; not a spot is naked; the paddy ground being enlivened with the presence of the rice crop, and the forest waste adorned with grasses and elegant flowers. The rice ground is very limited, and is situated at the lower part of the vale, in the immediate vicinity of the village of Gallipooti. It is divided into parterres, or small inclosures, fenced with impervious hedges of pricklypear *(Euphorbia neriifolia and terucalli.)* The whole island is one mass of rock, and the thin scattering of soil which hides but scantily the main constituent of the island, is merely derived from the disintegration of the latter. At the southern landing place there is a ledge of large masses of amygdaloid, (of which the cavities have been washed empty, if we except a few nodules of quartz) over which the surf beats high and renders landing dangerous, although it forms one of the few situations in these islands, where boats can reach the shore without grounding.

Near this landing place is a Portuguese ruin, situated on a knoll, and adjoining it, we discover the extraordinary artificial figure from which the island derives its European name, for its Hindoostani name is Gallipooti. The animal represented by this sculpture is evidently an elephant, fully equal to the natural size, and, upon the whole, well executed. The trunk and head have been separated from the body, and lie fractured and prostrate on the ground. Considerable damage has been done to other parts of the figure, for the instrument of which we must have recourse to the tradition current in that neighbourhood, which states that the Portuguese went so deliberately to work as to employ cannon in effecting their barbarous work of destruction, from the idea, as we have shewn, of extirpating superstition! The rock of which the figure consists is a very hard basalt, (No. 2.) containing a few minute cavities, scantily supplied with mineral crystals, and is of the same nature as the rock of the adjoining hillock. From this spot the ascent of the western hill is pretty easy, the pathway leading along the bed of what constitutes a torrent during the wet season, formed in the porphyry and amygdaloid, and runs to a considerable depth; a kind of natural walls rising up on each side, which are overshadowed by carissa bushes (Carissa carandas,) agnus castus* (Vitex trifolia,) the garruga tree (Garruga pinnata,) with its abundant fruit hanging in clusters, like the produce of the vine and castor oil tree (Ricinus communis,) while the soil is ornamented with the solanum (Solanum Jacquini,) and the Mexican Argemone † (Argemone Mexicana.) About half way up the hill the smaller temple or caves are reached. They are three in number, having the face of the rock polished perpendicularly, and some pillars formed on its surface, with several figures represented flying in the clouds. The inferior part of the rock consists of a variegated porphyry, sometimes reddish, and frequently of a yellow tint, the basis consisting of clay, and the inclosed particles of altered quartzoze grains, &c. (No. 4.)

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* The leaves of this shrub are employed by the Hindoo women in some religious ceremony, as I found a quantity deposited on the convex stone in the lateral square compartment of the great temple.

† The occurrence of this plant, (a native of the New World,) wherever the Portuguese have formed settlements, is a striking instance of the agency of man in the distribution of vegetable species. In addition to the habitat here given, I have observed it at Malabar Point in Bombay Island; on the Island of Coulaba; and at the south end of the town of Macao, in China, in all of which localities it is an abundant plant, affording a parallel case with that of the Chenopodium ambrosioides, (cited by Lyell, vol. ii. p. 83.) which we observe so abundantly in the Island of St. Helena.

Remains of painting are still observable, which seems to have originally been of a red colour, but has in some places faded to a purple hue. The upper part of the rock, commencing at the roof of the apartments, is composed of amygdaloid, having a wacké basis, and containing cavities filled with rock-crystal, calcareous spar, zeolites, and many other minerals which a careful examination would readily detect. During the rains these caves are filled with water. The whole face of the hill above these caves is craggy, consisting of amygdaloid, porphyry occasionally appearing, and is covered with thick jungle, and climbers ascending the stems of the numerous trees. Among the former we chiefly remark the Dalbergia scandens, and among the latter, the Getonia floribunda, with its bunches of flowers.

The path, continuing to wind up the declivity, conducts, after passing a fine specimen of the tamarind tree, and of the Asclepias gigantea to the great temple which faces the north. Like the lower antiquities, it is an excavation in the solid rock, with, however, a much greater extension of human art, for the space included within the walls of the large apartment is a square of 43 yards,* and 18 feet in height, supported by three rows of pillars, consisting of rounded fluted capitals and square shafts. The walls are covered with gigantic figures, all of which have been mutulated, with the exception of the colossal representation of the *Trimurti* fronting the entrance, and one entire masculine form in the recess to the right. The rock is amygdaloid, occasionally assuming a purely porphyritic appearance. The effects of the atmosphere upon the more exposed portions of the rock are obvious, for it is evidently decaying and crumbling to powder, and, combined with the ravages produced by visitors, would, in the lapse of time, prevent the probability of any remnant continuing, had not the foresight of the honourable governors of the country obviated the latter cause in some measure, by stationing a resident sergeant to guard these interesting relics. The rock, when first exposed, is highly indurated, and difficult either to fracture or polish, both of which circumstances add greatly to the wonder and admiration with which we must view the temple and sculptures.

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* This number is derived from the resident sergeant. I made it forty-six paces.

In geological investigations, not the least interesting inquiry consists in observations with regard to the degradation of the rocky masses, and the formation of the soils for the growth of the members of the vegetable kingdom. Such questions, it is obvious, can be most satisfactorily solved on insulated lands, where no agencies save the pure natural causes can come into operation. Coral islands, which are of such recent formation, present the most simple illustration upon this point, where we find the calcareous masses splitting under the action of the sun's rays, crumbling and affording a scanty soil for foreign seeds floated by currents to take root, and thus to extend the formation of the soil, by the loosening power of their roots and the fall of their leaves.[*]

The heat of the sun alone may be considered, therefore, a powerful auxiliary in the production of soils, and this influence is especially applicable to the Indian climate, where the dark hue of the rocks greatly favours the imbibition of heat; an observation similar to that which was made by Link, with regard to the black slates of Pezo,[†] and subsequently by Humboldt, was demonstrated in reference to the black bare rocks on the banks of the Oroonoko, whose temperatures were found to be elevated during the day 34¾° F., and during the night 18° above that of the atmosphere.[‡] In India, at the termination of the rains in September, the porous stony masses must of course be saturated with moisture, and when the rays of the sun excite their influence, and are imbibed, the water must necessarily be vaporized, and disintegration of the rocky masses ensue. This effect of vapour must be considered as a powerful agent, although not so explosibly effective as the freezing of water:

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[*] Dr.R. Forster has well described the structure and mode of formation of coral islands, in Cook's Voyage, of whose accuracy the present writer had ample proofs, while examining similar deposits on the coast of Sumatra. A fuller, but not more distinct account of coral islands is detailed in Beechy's Voyage.

[†] Link's Travels in Portugal, 8vo. 1801, p. 64.

[‡] Humboldt's Pers. Nar. vol. v. pt. i. 26.

> ——— "cum tristis hyems etiamnum frigore saxa
> Rumperet."[*]

Because, in one case the confined body has some means of egress, though far from free, while, in the other, the barriers must yield on every side to the overwhelming mass within. When the soil is carefully examined, all the appearances confirm the idea of its derivation from the rocky mass. It has a black colour, which it may in some measure derive from particles of oxide of iron, which are occasionally observable in the porphyry where it has begun to decompose, and from the vegetable matter derived from the trees. No considerable portions of iron have been detected in this neighbourhood, although the oxide of that metal is found in considerable abundance among the Ghauts, and is smelted with some profit at the Mahabuleshwar hills.[†] In consequence of the mixture of vegetable matter with this light rocky production, the soil has been rendered fit for raising some scanty crops, which serve to support the inhabitants of the island, who amount to about a hundred. It is a curious fact in the history of this island, that no water can be obtained by sinking wells near the beach, and that the sole supply of the inhabitants is procured at the summit of the hill, where a cool spring exists in a dark cave near the great temple, affording a plentiful supply, from which it is conveyed by the Hindoos to their habitations in porous earthen vessels.

CARANJA ISLAND.

This is a large island, situated the most southerly of any in the harbour. It consists of two hills, with an intervening valley. The best landing place is situated on the north-east side of the island, at a fishing village, where, however, the water is very shallow, and where it is necessary, in order to effect a landing, to employ a native canoe. The shore here is bounded by rocks, as at Elephanta, of the amygdaloidal species. The shingle consists of bivalve shells (Arca granosa) and waterworn porphyritic gravel. The ascent of the lesser Caranja hill is gradual and easy from the village to the summit of the ridge. The rocks have an inclination to the east and west, as if shelving down on each side of the ridge, presenting the appearance of stratification, or successive deposition, and are covered with low jungle of carissa, ixora, euphorbia, and lawsonia. The descent on the west leads to paddy ground, where there is another village, surrounded with neat gardens, and supplied with a tank, fifteen or twenty feet in depth, dug out of the solid rock, with a wheel and earthen pots to raise the water, as is usual in the east. In this valley there is a fine specimen of the Adansonia digitata, sporting a colossal trunk, and spreading out its branches to overshadow the circumjacent cultivated ground.* To reach the top of the ridge it is necessary to cross several mountain streams, whose beds are dry except during the rainy season. The rocks are all amygdaloid, on the western as on the eastern declivity, filled with zeolites, &c. and are well exposed in the streamlets, sometimes rising in the form of round masses, at other times shelving out and affording a level run for the water, and then terminating in a small perpendicular fall at the edge of the rock.

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[*] Virg. G. iv. 135.

[†] "Account of the convalescent station of Malcolm Pait on the Mahabuleshwar hills," Bombay, 1830, pamphlet. The chemical nature of the ore is not stated in this publication, but it is probably the magnetic iron ore.

On the eastern side, in this manner, a very picturesque waterfall is formed, the height of the vertical face of the rock being at least twenty feet, over which the whole water of the torrent is precipitated in one sheet, presenting altogether with the rich foliage of the tamarind in the foreground, a pretty scene. Near this a specimen of mesolite was obtained, among innumerable minerals, which may be observed scattered about on the surface of the island, very frequently covered with a blue coating, produced by the presence of iron. Besides mesolite I observed calcedony, agates, rock-crystal, calcareous spar, and heulandite.

The south-east point of the small hill consists of craggy rocks of porphyry, affording, in their numerous recesses, abundance of hiding places for lizards and serpents, especially the Cobra de Capello, which is extremely frequent in these islands. The clefts also afford good habitats for the fern Gymnogramma chylomelanos, and the Asparagus sarmentosus.

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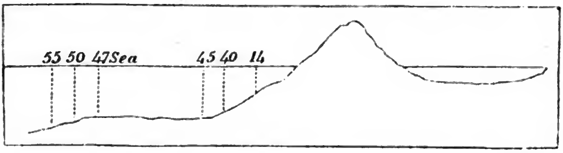
* In this valley I found a specimen of the Agaricus campestris, the identical English ketchup mushroom, of the existence of which plant, in this part of India, at such a slight elevation above the sea, I have never previously heard.

The large Caranja hill is similar in its conformation to the smaller hill, and is crowned by the ruins of an old fort, which was a place of considerable note, when Europeans first settled on this coast.

At low water the island is connected with the continent, the intervening valley being quite green, and studded with a few pools of water. The vale which separates the two hills, and divides the island into two parts, is covered with palm trees, amid which are situated cottages and rich gardens, at a small elevation above the level of the sea.

GENERAL OBSERVATIONS.

In the course of the preceding remarks it appears that, on the continent and along the coasts of the different islands, the soundings do not deepen suddenly, but that the water at the shore is shallow, and that it gradually increases in depth in proportion as we recede from the land. The same remark applies to the whole coast, from the Persian Gulf to Cape Comorin, and, it is on a careful attention to the depth of water and the nature of the bottom, that navigators in stormy weather must depend. In the latitude of Bombay this remarkable sub-marine portion of land which can thus be reached with the lead, attains an additional degree of breadth, jutting out to a greater extent into the Arabian sea, and, from its occupying such a considerable space, and affording good fishing ground, although it can only be considered as an expansion of the shoal water along the coast, it has been termed the Bank of Soundings. The deposit generally obtained in the bottom of the harbour, and on this bank near the coast, consists of a blue clay of a stiff nature, and is, therefore, serviceable by affording good holding ground for anchors. A section, representing the relative situations of the sea and the Bank of Soundings, will explain the subject more clearly than can be expressed by detailed descriptions. The horizontal line represents the sea level, and the inclined one the bottom of the ocean,



which is here shewn to be a gradual descent from the summit of the high land. By sounding regularly we discover our distance from the coast, as appears from the following table :—

10 miles from the coast the soundings are 14 fathoms; bottom, mud.
40 do. 40 fms., sand, gravel, and shells of various colours.
50 do. 45 do. do.
160 do. 50 do. do.
170 do. 55 do. do.

We observe, therefore, that soundings extend as far to the westward of Bombay as 2° 50′, and that, until the bottom of the ocean begins to ascend, in order to come to the day; the bed consists of sand, mixed with shells, and that then it is formed of mud. An observation with respect to the nature of the shells would be of considerable importance, because it might enable us to decide, whether they are natives of deep water, or belong to the shallower parts of the ocean.

Two explanations occur, to account for the appearances here described, either, 1st. That the land and ocean have retained their positions relative to each other since the formation of the first, the production of the bank being similar to the clay deposit round the shore of the island which so lately appeared, and sunk in the Mediterranean ; or 2d., That the harbour of Bombay was formerly a valley, and that the Bank of Soundings was at one time dry ground, both of which have been submersed by the gradual encroachment of the sea. The most undoubted evidence exists to shew us that this coast has been, even within the range of a few centuries, subjected to violent convulsions from earthquakes

In May 1618, six years after the settlement of the English at Surat, " a general and diabolical storm" occurred in the neighbourhood of Bombay (*Bombaim* as it is termed by old writers). It began at Baçaim (Basseen,) on the 15th of that month, and continued with such violence that the people hid themselves in cellars, in continual dread lest their dwellings should be levelled with the earth; and at 2 A.M. an earthquake destroyed many houses. The sea, according to the historian of the time, was brought into the city by the wind; the waves roared fearfully; the tops of the churches were blown off, and immense stones were impelled to vast distances; two thousand persons were killed; the fish died in the ponds; and most of the churches, as the tempest advanced, were utterly destroyed. Many vessels were lost in the port. At Bombay, sixty sail of vessels, with their cargoes and some of their crews, foundered.

At Agaçaim, a boat was blown by the force of the wind from the sea into a house, where it killed a woman and her child, and the trees were torn up by their roots.

Besides the presence of a violent commotion in the atmosphere, and the powerful concussion of the earth, volcanic action seems to have occurred, if we may be allowed to deduce such an inference, from the highly embellished representations of the historian, of giants seen in the air throwing great globes of fire at each other, confusions of human voices in the atmosphere, tramplings of horses, and the sound of warlike instruments. It is added that much of this nature occurred in " Salsete," and other places.*

The metaphorical figures expressed in the latter part of the description, are strikingly similar to those employed by Dion Cassius † in his account of the eruption which destroyed Herculaneum and Pompeii, where we are told that giants were seen, and the sounds of trumpets were heard in the vicinity.

Frequent mention of earthquakes may be found in the history of the Malabar coast, (which extends from Cananore to Cochin, about 42 leagues,) where they go under the denomination of *Bhumiculacam*. In 1784, a strong concussion was felt, and in the province of Nagaracotta, as well as on the bank of the river Sarayuva, volcanic appearances are evident. But the most remarkable changes are to be found in the vicinity of Cochin. On its north side we find the Island Vaypi, which was thrown up by the sea about the year 1341. The soil upon this new formation resembles that of the flat districts of Malabar, which consists of sea sand and calcareous matter, combined with clay said to be washed down from the Ghauts. The production of Vaypi gave rise to a new era, termed *Puduvepa* (new introduction.) In the same neighbourhood, Bartolomeo informs us, that he was witness to the formation of an island, a mile in length, in the course of ten years, before the church at Celtiyatti, by the opposite effects of river and sea water, which may be explained in the following manner: During the months of August and September, if the rains have been abundant, the waters of the river clear away from its mouth, those sandbanks which have been formed during the height of the monsoon, in June and July, by the high sea which then rages in a boisterous manner; but if the rains have been scanty, and the force of the river is not sufficient to carry away the obstruction to its junction with the waters of the ocean, an inundation of the adjacent country ensues; the inhabitants are driven from their dwellings, and so frequent is this occurrence, that we are told grandchildren can scarcely point out, with any certainty, the spot where their grandfather resided, in consequence of the change in its appearance.

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* Sousa's " Portugues Asia," tom. iii.

† Hist. Rom. lib. 66.

Contemporaneous with the appearance of the Island of Vaypi, the waters which during the rainy season are discharged from the Ghauts, broke through the banks of the river Cocci, and overwhelmed a village of the same name with such impetuosity as to sweep it away, and formed in that district a river, a lake, and a harbour so spacious, that very large ships can now lie in security on the north-east side of Cochin, where the river runs into the sea.*

According to the Hindoo records, the ocean has made great inroads upon the opposite shore of India; for, it appears, from the researches of D. Duante de Meneses, Portuguese governor of India in 1522, among the native writings, that " Miliapore," seven leagues from " Paleacate," the ruins of which were then on the sea shore, was surrounded, according to tradition, 1500 years previous to that date, by 3,300 stately churches, and that the site of that most ancient city was distant twelve leagues from the sea. We are also informed that " St. Thomas dragged out of the sea an immense mass of timber, which all the force of elephants and art of men could not move."*

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* Viaggio alle Indie Orientali da F. P. da S. Bartolomeo, Roma, 1796, 8vo. English translation from the German of Dr. R. Forster, 8vo. 1800.

In the figure which we have given, it is evident that the inclined plain at the land has been comparatively but recently submersed, while the horizontal bed has been for a longer period subjected to the action of the sea, as is evinced by the layer of sand and shells. The whole of this horizontal portion, likewise, we may decidedly conclude, was inundated at the same period, for, after the sea had been raised to the level of forty-five fathoms from the present surface of the ocean, we can see no impediment to its laying the whole plain, extending for at least a hundred miles of longitude, completely under water.

The Hindoos, on the Malabar coast, have a tradition that the sea extended to the foot of the Ghauts. There does not appear, however, evidence tending in any degree to prove that such an occurrence has been of recent date; but we are rather disposed to consider the native account, as an indistinct remnant of the almost universal tradition of a deluge during the human era.

The agencies of torrents appear of too trival a nature, to afford a sufficient source of such an extensive submarine formation, as that which we observe along the Concan and Malabar coasts, although there can be no hesitation in admitting that where considerable rivers do exist, the *debris* collected by the force of their currents must prove a serious obstacle to the encroachments of the ocean. But at Bombay, where the bank is much broader than in other parts of the coast, no remarkable accumulations occur at the mouths of the rivers Panwell and Pen, whose size, indeed, is sufficient to render such an occurrence extremely improbable, even if actual examination did not demonstrate the fact to be as we have stated; and the extensive portion of land in Salsette, which is dry at low water, is situated beyond the influence of any current save that of the tide, which it must be admitted, however, is extremely powerful.

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* Sousa's " Portugues Asia," tom. i. 270.

There seems no reason, then, for supposing that this bank has been formed by matter forced down by the agency of running water from the Ghauts, as some have concluded, because, it exists where there are no rivers to produce accumulations, and it is broadest at the mouths of the smallest rivers.

In bringing forward proofs of extensive changes and violent convulsions, we have endeavoured to exclude theoretical considerations, and probability is only implied when we observe that the different islands in the bay may have been the continuation of the high land in Salsette and Tull, whose communications have been submersed, and whose bases are now washed by the overwhelming waters of the ocean.

ARTICLE III.

Geology of Estramadura, and the North of Andalusia. By M. F. LE PLAY. *(Ann. des Mines, vi. 297. 477.)*

THE portion of country described in this paper is included between the Rivers Tagus and Guadalquiver, on the north and south, and between La Mancha and Portugal on the west and east. Interesting as this district is, both in a physical and moral point of view, it is strange how little information we have respecting it. The cities of Seville, Cordova, and Badajoz, are the only names belonging to it which are known to the rest of Europe, while Truxillo, Merida, and Medellin are merely noticed as military stations during the Peninsular war. Estramadura, and the Sierra Morena, which border it on the south, form an inland country, at a distance from high ways, and remarkable for its vast pasture lands, which serve to support large flocks of Merino sheep. On account of the paucity of the population, no travellers have examined its Geology, for, the only allusion, in a scientific point of view, to this portion of Spain, which M. Le Play could discover, was in the small work of G. Bowles, which was translated into French in 1776. The maps of this district, as might hence be expected, are very imperfect. M. Le Play states that by far the most accurate is that of Bory de Saint Vincent. The author has, however, constructed a geological map, which, as far as his observations extended, may be considered as correct, and as a most valuable contribution to Science.

The central portion of Estramadura, about Talarrubias, consists of a plain, which is elevated about 550 metres (1804 feet) above the level of the sea. The town of Puebla d'Alcocer, lies 50 metres above this plain, or 602 metres (1975 feet) above the sea, which is almost exactly the altitude of Madrid, and of the plain of New Castile, which insensibly sinks towards the south-west, as it approaches Estramadura. M. Le Play considers this plain as bearing a striking resemblance to that of the Western Hartz, not only in its corresponding elevation, but likewise in its geological structure, vegetation and climate.

It preserves an agreeable surface, being distinguished by ancient, inclined, and occasionally crystalline rocks, and traversed by a few rivers, whose channels are about 160 or 170 feet deep, and of whose existence the traveller is not aware till he approaches the ravine in which they run. Even the largest of these, the Guadalquiver, is fordable in June, above Seville, and the Guadiana is seldom in a state to prevent its being crossed in the same manner.

The valley of the Guadiana is depressed 190 feet below the level of the transition plain. The alluvia of its banks rarely extend above 200 feet from either bank, and frequently one of its banks consists of a vertical wall of schist or greywacké. As the river leaves the Sierra d'Alcocer, however, its escarpments disappear, and plains extend on both sides. The valley of the Tagus is also deep, and where it enters Estramadura, this river appears to force its way with difficulty through a mountainous district. Very different, however, is the character of the Guadalquiver, which traverses the plain of Andalusia, whose elevation little exceeds the level of the sea. The plain, which extends on the left between Cardova and Seville, is not raised more than fifty feet above the bed of the river.

The ridge of the Sierra Morena follows the direction of the Guadalquiver, from Cordova to Seville, which is a west south-west course, but to the north, the limit, although not so definite, may be said to be included between Llerena and Guadalcanal. In fact, the inhabitants of Estramadura, and of Andalusia, differ in their definition of this ridge, because, the mountains being about 1600 metres (5249 feet) above the level of the sea, the former, in order to reach their summit, have a less ascent, by above 500 metres, (or 1700 feet) than the latter. This chain appears to be formed of several groups, which may have been at first separated, but have been joined by some convulsion. The Sierra de Guadalupe give a mountainous character to the country, between the Tagus and Guadalquiver, and consist principally of granite, according to the reports of the muleteers. The Sierra de Solana lie to the west of this ridge, and are distinguished by their stratified graywacké formation.

The country extending between the Tagus and Guadiana is characterized by numerous broken ridges, some of which rise 1700 feet, and consist of granite. The depressions which connect them are termed *Puertos*. Between the Guadiana and the Sierra Morena, we find numerous ridges, under the name of Sierra de Hornachos, running from south-east to north-west; Sierra de San Servan, running north and west; Sierra d'Alcocer, 350 metres above the plain, consisting of quartzoze rocks, extending west and north; Sierra de Cabeza towards west and north. To the south of these chains is situated the country of Almaden, which is formed of four rectilinear ridges of hills, the highest of which is 400 metres (1312 feet) high, and consisting of quartzite. This district presents to the eye a very barren aspect, and the traveller cannot understand why such a considerable population should be attracted thither, until he learns that rich veins of cinnabar exist in the barren rocks. To the south of Almaden, between the Rio Alcudia and Guadalmez, another ridge exists, elevated 450 metres above the former river, in whose vallies immense masses of quartzoze sandstone are observed. The western portion of Estramadura, comprised between the Tagus and Sierra Morena, is varied with numerous chains of subordinary hills, attaining a height sometimes of 400 metres (1312 feet) possessing a rounded outline, and entirely destitute of arborescent vegetation. These chains are frequently interrupted by parabolic hills with a vertical axis, which have generally been taken advantage of by invaders, for military stations.

Estramadura, therefore, may be described as an elevated plain, 550 metres (1804 feet) above the level of the sea, and 500 (1640 feet) above the plain which borders the Guadalquiver, through which the Guadiana runs, at an equal distance from the Guadalquiver and Tagus, in a direction a little to the south of west, while the Sierra Morena, which traverses the south of the district, triples, in many places, the difference between the banks of the Guadalquiver, and the numerous partly isolated chains afford variety to a country which is always of a rude character. The different formations met with in this district may be considered in the following order, beginning with the most ancient rock:—

1. *Granite* constitutes a very considerable portion of Estramadura. Between Garlitos and Almaden, an isolated tract of this formation occurs, extending from north-east to south-west. The rock is composed of white felspar, reddish-brown mica, and small portions of quartz, in minute quantities, and possesses often a foliated structure. The most important mass of granite, to the south of the Guadiana, is that which lies on the north border of the Sierra Morena, extends from the east of Puerto Blanco to the west of Benalcezar, and is surrounded by hills of schist. The soil is derived from the disintegration of the granite. To the north-west of this basin, a considerable extent of granite is met with, the limits of which are marked by Castuera, Campanario, Quintana, Zalamea, Malpartida, and Bengareucea. On its eastern boundary the formation is covered with granitic sand, and the rock possesses an olive-green colour, derived from the mica.

In the middle of the formation, near the ancient mine of *El-Chantre*, which has been long abandoned, the felspar has, in decomposing, assumed a grayish appearance, and the rock is covered with rusty stains, produced by the action of the weather upon the mica. About Quintana the granite consists of small grains, the hyaline quartz and felspar forming a beautiful white basis, through which mica is plentifully distributed. Here also occur large tabular masses of granite, sometimes 100 feet in diameter, which have become polished by the atmospheric influences. At

Zalamea, a species of black porphyry appears, consisting of a basis of amphibole and felspar, through which felspar is disseminated; M. Le Play calls it Melaphyre. Although granite appears so frequently among the transition rocks on the table land of Estramadura, it is seldom met with among the rocks of the same formation in the Sierra Morena, and when it does occur among these mountains, it is generally in a deep bed of a rivulet, as at Villaharta, in the channel of the Rio Cuzna. Here the greywacké and schist appear to be impregnated with the debris of the granite. On the south of Pedroso, granite, to a small extent, occurs, which, in decomposing, has given origin to a thick layer of sand overlying it.

On the north of the Guadiana, the rock appears at Albuquerque, containing very large felspar crystals, which, in decomposing, become gray, and give the rock an appearance like trachyte. The quartz is reddish. The town presents a remarkable appearance, in consequence of the houses being built among immense masses of rock, which has produced the most tortuous streets imaginable. At Malpartide another tract appears, where, from the nature of the soil, large reservoirs of water have been formed for washing the wool, which forms the staple product of the industry of this country. The hills in this neighbourhood are covered with rounded blocks of granite, lying over the granite soil, and appearing to have no connexion with the subjacent rocks. Hence, the inhabitants consider these the work of human industry. M. Le Play explains their origin very satisfactorily, by considering these masses to have been connected by narrow necks to the subjacent rocks, and that this bond of union gradually decomposed, and left the main portion of the blocks above the disintegrated matter. The Sierra de Montaches, consists of granite, but the effect of external causes in decomposing it are not nearly so apparent as at Malpartida. A long band of granite extends from the Tagus, by Truxillo, south easterly to Torita, at no great distance from the Guadiana. Detached blocks are observed distributed as at Malpartida, upon the hills, the origin of which admits of a similar explanation.

Euphotide and diorite.—These consist of compact felspar, containing a great quantity of crystals, or lamellar pieces of diallage, which possesses generally a green or greenish-brown colour. They are very hard, and are not easily decomposed. Near Almaden, in the bottom of a valley, a great quantity of blocks of euphotide exist, which are employed for fencing in the road to Madrid. It is compact, and admits of a fine polish, the diallage frequently approaching the appearance of actinote. It deserves to be noticed that in the cinnabar veins of Almaden, large portions of a rock analogous to euphotide are met with. At Guarena, and upon the banks of the Guadiana, near Merida, euphotide occurs in the tertiary beds. On the right bank of the Guadiana, near Badajoz, the same rock is met with, associated with dolomite and travertine, or porous limestone, containing fresh water fossils. Sometimes the diallage is distinct in the felspar basis; it often contains actinote passing into asbestus, pyrites, quartz, green talcose mica, and chlorite in small scales. To the south-west of Albuquerque, there are, fragments of euphotide similar to those of Almaden, and considerable quantities are found on the greywacké, which extends as far as Portugal to the west of this city, in which country it very probably occurs *in situ*.

Near Cazalla, in the Sierra Morena, large blocks of euphotide are strewed about, consisting of greenish felspar, and of olive-green diallage, interspersed with small fragments of protoxide of iron, which are sometimes so abundant as to form the principal portion of the rock. At Pedroso, Fuente del Arco, and Higueira, rocks possessing a granitic structure, consisting of felspar and quartz, occur. They appear to be of the same nature as euphotide. Associated with the euphotide of Almaden, there are trap blocks on the tops of the hills, having often the aspect of basalt, and are obviously euphotide or diorite, cooled under different circumstances.

2. *Mica Slate* shewing itself near Albuquerque, in contact with granite, is composed of a clay-slate basis, impregnated with mica or talc, and gradually passes into clay-slate. Near Cordova it also occurs in the midst of transition rocks, and in contact with granite at Pedroso, where the quartz predominates, and gives the rock the appearance of gneiss.

3. *Secondary Rocks.*—These correspond with those of the rest of Europe, and afford a strong presumption of the

uniform nature of the causes which have given origin to the different formations. They lie over the mica slate in the following order: clay slate and talc slate, alternating with greywacké, and always with thick beds of quartz. Limestone also is common on the heights between Llerena and Guadalcanal, apparently belonging to the same series of rocks. The mountain chain extending to the south of Almaden consists principally of layers of quartz, without any trace of fossils; but at the lower grounds, where we find sandstone and phyllades, passing into psammites, remains of animals are frequently encountered, similar to those of the secondary transition rocks of Britain.

In particular, a *terebratula*, with large whorls, and a fossil corresponding exactly with the *spirifer attenuatus* of Sowerby, have been met with, and similar remains have been observed at St. Eufemia and Espiel. Hence, it appears that there have been two periods in the transition formation of Almaden, but their proper discrimination would require a very attentive examination.

Clay slate alternating with talc slate, constitutes the basis of the transition formation of Estramadura. The first has a fine grain, slightly sonorous, with a beautiful blue slate colour, and is sometimes separable into very thin plates. The latter varies a good deal in the relative proportion of its constituents, and passes often into *phyllades*, a rock which contains much mica, agglutinated by a sandy or earthy basis, and frequently resembling the *psammites* of the variegated sandstone formation. Greywacké, however, is the predominant transition rock. Between the Sierra d'Almaden and the Rio Guadalamez, it is very uniform in its structure, and is the only rock met with between the granite of Albuquerque and Malpartida. It abounds, although mixed with *phyllades*, in the neighbourhood of Talarrubias, Orellana, Espiritus Santi Cabeza del Buey. It is generally characterized by consisting of compact, hard and fine grains, with a gray colour.

The quartz rocks do not exist to such an extent as in Scotland, but are merely found in thick beds subordinate to the transition rocks. In the hills between Espiritus Santo and Almadan, the quartz is very compact, resembling *eurite*, and frequently passes into sandstone. M. Le Play considers that the quartzoze chains have not been elevated, but have been, as it were, sculptured out by the gradual degradation of the surrounding country, the constituents of which are much less durable than the indurated quartz.

The limestone of Llerena is very rich in metals, and forms the summits of the mountains which run from south-east to north-west, crossing the road from Badajoz to Seville. The silver mines of Guadalcanal are situated in hills of slate and greywacké, at the south-east extremity of this limestone ridge. More southerly, compact and saccharoid limestone is often met with, as at Cazalla and Pedroso.

The *coal formation* does not occur to any great extent in Estramadura, but, being distributed in small patches on the surface of the transition formation, throws some light on the geology of the district. Impressions of *equiseta* and *filices* exist abundantly in the rocks of the coal basons. The valley of Espiel, which is probably united with the coal bason of Valmez, is surrounded by high transition hills. The predominating rock is a quartzoze conglomerate, passing into pudding-stone, and is often impregnated with oxide of iron.

The inhabitants raise for their own use a little coal, but never dig deeper than nine or ten feet. It is very friable, but possesses all the other qualities of good coal. The coal basin of Fuente del Arco is surrounded by greywacké rocks, and is situated at the foot of the limestone ridge of Llerena. At Alanis, where coal has been dug, in addition to conglomerates and psammites, an argillaceous rock appears, containing felspar and ochre. The bason of Villa Nueva del Rio, on the Guadiana, is the only place where coal can be said to be worked. The surface of the earth consists here of conglomerate or pudding-stone. Below it are found layers of coal and slate-clay, which is black, bituminous, and contains numerous fossil impressions. The coal is of good quality, but has only been extracted from the superficial bed, by numerous pits which cover the surface. It is consumed principally by the steam boats, and at the forges of Pedroso.

4. *Tertiary Rocks.*—Near Cordova these rocks appear in the form of shell limestone, of a porous structure, containing the remains of many animals, and among others, a

terebratula and *echinus*, identical with those found in Corsica. According to Deshayes these fossils characterize the second tertiary period, of which there is an example near the Straits of Bonéfacio. The limestone beds have a slight inclination, and appear to repose on slate and compact limestone, penetrated by veins of carbonate of lime. The hills formed of this modern limestone, are separated from the right bank of the Guadalquiver, by an alluvial band, forming a small plain upon which the city of Cordova, with its gardens, is situated. The left bank is formed of a steep wall of gray marl, corresponding with the gray marls which accompany the gypsum of the Paris bason. No organic remains were observed, but it is probable that they do exist. At Badajoz, a small chain of limestone hills crosses the course of the Guadiana, forming a steep escarpment on its bank. On the west of this precipice reddish-gray marls occur, possessing the characters of travertine, and near it are found fresh water fossils. Towards the east, the shell limestone is replaced by alternate layers of dolomite and compact rocks. The dolomite is crystalline, with a yellow colour, sometimes filled with small cavities, and interspersed with rhombohedral crystals. The rock itself is not slaty, but is deposited in thick beds, which are separated by thin layers of slaty rocks, which are white, earthy, and contain talc, sometimes becoming compact. Associated with them are crystalline rocks, consisting of felspar and amphibole, and crystals of diallage, resembling euphotide, or the black porphyry of Almaden. Sometimes, also, they contain green mica, pyrites, and chlorite. No dolomite is found among the transition rocks, and hence, M. Le Play conceives that the dolomite formation of Badajoz is an altered state of the lacustrine rocks, and that this modification is connected with the infiltration of masses of euphotide.

Two specimens of this rock afforded, by analysis, the following constituents :—

Lime	30·0	-	29·0
Magnesia	19·2	-	18·4
Protoxide of iron	2·6	-	4·3
Carbonic acid	46·4	-	45·2
Earthy matter	·5	-	2·2
	98·7	-	99·1

Corresponding to Ca. C + (Mg. *f*) C *

Over the shell limestone is superimposed, at Cordova, an argillaceous formation with rolled flints, which has obviously been transported thither as in Old Castile, Murcia, Cape Palos, Marbella, and is considered as indicating a third epoch in the tertiary series. At Badajoz similar appearances present themselves, in the form of conglomerates, with flints, rising about 200 feet above the level of the Guadiana. The fragments of conglomerate generally consist of quartz, greywacké, slate and large flints. In the Rio Gargaliga, reddish quartz appears; the low plains of Serena and Guadiana consist of fine silicious sand; the hills in the neighbourhood of the Guadiana are covered by clay, with or without flints, renowned for its fertility, and termed in the country *tierra de barros*. In addition to this formation, numerous more recent disintegrations are observed in different situations, deriving their origin from atmospheric influences.

Minerals.—Estramadura contains a vast variety of metallic minerals, which, if properly employed, would raise this district to the first distinction.

Mercury is found in large deposits in the form of cinnabar, and native mercury occurs in the hill upon which Almaden is built. The veins are parallel, almost vertical, and are distant about sixty-five feet from each other. Their mean breadth is about twenty-six feet, but sometimes the absolute diameter is double this measurement; the depth at which they are worked is about 820 feet. One of these veins is termed *San Diego a levante*, and the other *San Francisco a levante*.

The rocks which the veins traverse are principally quartz and clay-slate. At the south-west of the first vein, there is

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* Magnesian limestone very often occurs in alternations with porphyry. In Durham, breccia is connected with the extensive dolomitic beds; and in Berwickshire I have described it (Loudon's Mag. of Nat. Hist. v. 627.) as alternating with claystone-porphyry. Analysis shewed its composition to be,

Carbonate of lime . .	49·6
Carbonate of magnesia .	44·
Silica	4·
Peroxide of iron . . .	1·2
Alumina	1·
	99·8

This is, abstracting impurities, = Ca. C + Mg. C.—Edit.

a rock which the miners term *freylesca*, formed of small distinct fragments of talc or clay-slate, possessing a dark-gray colour, with a structure resembling some species of porphyry. It is more easily worked than the other rocks, and is conjectured by M. Le Play to be connected with the formation of the veins. The veins themselves are formed of compact quartz, impregnated with cinnabar, and a small quantity of native mercury. Sometimes the matrix of the mineral is a black bituminous slate, which becomes white by calcination.

Notwithstanding the thickness of the vein, in consequence of the good system of mining, its mass is extracted entire. Frequently pieces of perfectly pure cinnabar are obtained. A cubic metre (35·317 Eng. cub. feet) of the ore in a rough state produces 325 kilogrammes (2 cwt. 11 lbs.) of mercury. The mining is conducted by driving successive levels or galleries, at different depths. The total depth of the pits in May 1833 was 307 varas, (841 feet.) The annual product of the mines of Almaden is 22·000 quintals (1078 tons.) Hence, this spot alone furnishes twice as much mercury as all the other mines together, in Carniola, Hungary, the Palatinate, and Peru.

Silver mines, according to tradition, were anciently worked in Estramadura and the Sierra Morena. Those best known are at Guadalcanal. In the middle of the seventeenth century silver was raised here and at Cazalla, from the transition slate, mixed with sulphur, antimony, and arsenic. Silver is also said to exist about Logrosan and Zafra; and M. Le Play heard that mines of this metal had commenced successfully to the west of Pedroso. At *El Chantre* a silver mine is still shewn, but nothing could be detected among the debris but pyrites and galena.

Lead is found abundantly, in the form of galena, in veins in the stratified transition rocks. Defourcy found some specimens to contain the following proportions of silver and lead.

	Lead.		Silver.
Cardosa near Llerana	793·	-	000·63
Los Pobres	752·	-	000·47
Truxillo	789·	-	000·35
San Calisto, Sierra Morena . .	630·	-	000·30

Copper occurs in the same circumstances with galena, in the shape of copper pyrites, blue and green carbonates. The most common mineral is a mixture of green carbonate of copper and hydrate of iron. It contains 30 per cent. of copper, and is found near Talarrubias, where it forms singular veins on the surface, to the north of Anora, at a place called *Casa Blanca*, on the north of Cordova. These three varieties contain

	Talarrubias.	Casa Blanca.	Cordova.
Oxide of copper . . .	37·8	46·1	63·6
Water and carbonic acid	16·4	18·5	25·4
Hydrate of iron . . .	28·8	29·1	6·5
Quartz.	16·0	5·0	3·0
	99·0	98·7	98·5
Metallic copper . . .	30·2	36·8	50·8

The same mineral occurs at Garlitos in granite.

Antimony was mined during last century in the mountains of La Mancha; and in the bed of the Guadiana large blocks of sulphuret of antimony are met with.

Iron is plentiful in this district, in the form of red oxide, passing into *fer oligiste*, and red and brown hematite, deposited in layers and veins in the quartz which crowns the small chains of Estramadura. In the Sierra d'Orellana vast excavations are observed, which were produced for the extraction of this metal. On the right bank of the Rio Guezna there are thick layers of *fer oligiste*, which supply the works of Pedroso.

Such is the wealth of this province, which might be raised to opulence and luxury if the people were stimulated to industry.

Most authors who have written upon Estramadura, struck with the limited population, when compared with the extent of the province, have deplored the retrograde state into which it has fallen. The symptoms of this falling off are very distinct on the Guadiana, where large Roman cities are transformed into country towns. The nature of the soil, as depending upon the different formations, has had a decided effect upon the distribution of the inhabitants. The transition formation is in general much less fertile than

than the granite or tertiary beds. On the left bank of the Guadiana we often look in vain for any trace of vegetable soil.

. A fine thick herbage of aromatic *labiatae*, *liliaceae* and *asphodeleæ*, growing from the vertical portions of the slate and greywacké, affords pasturage during the winter and spring to wandering flocks which pass across New Castile to the sources of the Tagus.

In May these plains are beautiful, but on the approach of the heats of summer nothing is seen but a burnt surface, destitute of trees and bushes, with the exception of a few miserable oaks, whose wretched foliage only adds to the dismal nature of the scene. At the bottom of the isolated chains the case is different, for there vegetation flourishes, and springs exist which nourish the fruit trees and oranges as at Alcocer, Orellana, Castuera, &c.

The mountainous parts of the transition formation are well wooded, and are susceptible of good cultivation. Between the granite formations of Albuquerque, Malpartida, and Montachés, the surface is covered with cork trees and other species of oaks; but these trees are always at such a distance that the intervals may be sowed with corn. The inhabitants have no word expressing a wood or forest. The other mountains which constitute half of the surface of Estramadura, are covered with thick bushes, eight or ten feet high, consisting of plants which form the ornament of our gardens, as *Cisti*, especially *Cistus ladanifer*, *Pistacia lentiscus*, *Arbutus unedo* the tree heath, whose root produces an excellent charcoal, Spanish broom, several species of *rhamni*, the common myrtle which is frequent near Pedroso, and the rose laurel in the bed of streams. The Sierra Morena is covered with these plants, which give to it the sombre appearance expressed by its name, (black mountain.) The granite formation is more fertile than the preceding, and supports a greater population. And, notwithstanding the abundance of solid blocks which obstruct the agriculturist, granite hills, as at Torremocha, are well cultivated, and are ornamented with oaks whose acorns supply food for flocks of pigs.

In the same formation is situated Hinogosa, which enjoys a fertility superior to that of Touraine and Normandy.

But it is in the tertiary formations that the population has been principally developed. The plains of the Guadiana and Guadalquiver present prospects to the agriculturist which are sought for in vain over the rest of the country. It was on this fertile portion of the country that, under the Romans and Arabs, so many populous cities grew up. Here are situated Merida, with 4000 inhabitants; Cordova, which, in the days of Almanzor, extended for several leagues along the banks of the Guadalquiver, but is not now larger than a third-rate town in France; and Seville, whose ancient grandeur although no more, contains still 100,000 inhabitants.

In this country, where nature has been so profuse with her gifts, the whole land, even among the principal cities, lies desolate and waste, without promising any hope for the poor or security for the rich. How momentous would be the change should improved institutions and morals be introduced. Cultivation might be general, and, together with the product of the mines, the country would support a population twenty times as numerous.

The author draws some important inferences in reference to the causes of the appearances which the country of Estramadura exhibits.

1. The inferior transition formation and crystalline rocks upon which the former repose, are conformable, which shews that at the period when mechanical deposition began to succeed chemical eruption, no violent action occurred.

2. The passage from the first into the second transition period was marked by the appearance of the great chain of Almaden. The latter, after this event, formed the crest of a small island, running in the direction from east 40° north to west 40° south. This island was formed at the same time that Britain and the north of Normandy began to appear, its banks being inhabited by the same kind of molluscous animals which existed in the latter.

3. The termination of the second transition period was marked by the elevation of the land of Estramadura, but this first revolution did not raise it to the level which it at present possesses. Its surface had completely emerged, with the exception of some small lakes or gulfs where the coal formation was afterwards deposited.

4. The coal basins were not all originally concentrated in the Sierra Morena, where we find the present traces of them; but the deposits which were situated on the Guadiana have disappeared under the influence of the same causes, which have been already noticed as having wasted the surface of the land.

5. The tertiary basin of Badajoz reposing immediately upon the transition formation, it follows that the fresh water limestone appearing to occupy the inferior part of this formation was deposited in a basin which did not exist before the tertiary period. This affords proof of the occurrence of movements of the land at an earlier period, in addition to the vertical position of the marls and fresh water limestone of Badajoz. The characters of the euphotide and diorite, and their interstratification with the dolomite, shew that there is an intimate relation between the most recent revolution of the land in Estramadura, and the appearance of these crystallized masses. This connexion is similar to that which Dufrenoy has noticed between the revolutions of the third tertiary era on the two declivities of the Pyrenees, and the eruption of these crystalline rocks, composed of felspar and actinote, which he has termed *ophites*. That this relation does actually exist between the transported formation of Castile and Estramadura, and the third tertiary epoch of the south of France, is further proved by the circumstance that arragonite occurs in both places. The crystals observed in collections come principally from Molida d'Aragon and Mingranilla, near Cuença.

With regard to the direction of the chains and stratified rocks, Le Play considers that the first revolution which took place between the two transition periods, produced in the ancient transition strata, a rupture from east 40° north to west 40° south, a direction corresponding with the slate in the hills of Westmoreland, Hundsrück, &c.

This elevation is exhibited in a regular manner in the Almaden chain, and directs the course of the rivers.

The modern transition formation was elevated at the same period with that of Britain and Normandy. The mechanical action which produced this elevation appears to have exercised its chief force in a line passing through the axis of the granite basin of Torrenulano and Hinogosa, from west 12° north to east 12° south. This direction is indicated by the regular stratification of the slate and greywacké. The same appearances are exhibited to the north of Cordova in the hills which lie on the frontier of Portugal, to the west of Albuquerque, but there, regularity is in many places interrupted by more recent dislocations. An elevation posterior to the deposition of the coal appears to have passed from east to west 72° north, and presents itself regularly in the chain of Solana, in the country of Montanchés in the Sierra de San Servan, in the neighbourhood of Pedroso, and in the coal formation of Villa Nueva del Rio.

The revolution which has followed the third tertiary period, from east 17° north to west 17° south, is clearly indicated by the course of the rivers Duero, Tagus, Guadiana, and Guadalquiver. It is a remarkable fact, that some of the fissures which contain the mercury of Almaden follow the same direction as the hills in which they are situated. The author considers, that the production of these veins was contemporaneous with that of the *ophites*, which is confirmed by the circumstance of round masses of *ophite* being occasionally found in the cinnabar. It has been long thought that mercury was a recent formation, but the facts here stated shew that its origin is more modern than geologists had ever conceived. In comparing Estramadura with the rest of Spain, M. Le Play considers that the revolution which occurred after the first transition period, originated the rocks of Almaden, the eastern part of the Pyrenees by Castres and Carcassone, the Sierras D'Albarracin and Molina, as well as the granite and old stratified rocks, extending between Cape Ortegal and Cape Finisterre. These all extend east 40° north.

After the second transition era, a revolution running west 12° north, affected the whole of Spain, elevating the Pyrenees in Asturia, the modern transition portion of Estramadura, and probably, also the whole country between the Tagus and Guadalquiver. To the south, it produced also the Alpujarras, the Contraviesa, the Sierra de Lujar, and all the mountainous country between Malaga and Almeria. If a line be drawn through the small hills which form the eastern part of the Sierra de San Servan, it will form with the meridian an angle of 15° towards the west, and will run from Cape Ortegal to the pillars of Hercules. It thus points out a series of dislocations, which all assume the same direction, and which formed the isthmus which united Spain with Africa. The revolutions during the secondary period acted principally in the south of Spain. At the end of the secondary period, the revolution which produced the Pyrenees, gave to the mountains running from Cape Ortegal to Catalonia, the elevation which they at present possess. The coast between Catalonia and Cape Creuss was formed by the elevation of the Pyrenees, and several islands varied the surface of the sea, which extended from the Alpujarras chain to Corsica. On its shores lived the *echini* and *terebratulæ* of Cordova. But a great revolution speedily supervened, which formed the coasts of Catalonia, Valencia and Murcia, and elevated the western Alps.

Cape Forcas in Africa and the islands of Alboran are in the same line of elevation, and probably, constituted another isthmus, which joined Africa with Spain. The observations of Silvertrop upon the tertiary strata of Murcia, demonstrate that the third tertiary formation, reposes in horizontal layers on the inclined strata of the second era, confirming the theory of Beaumont. The strait of Gibraltar was formed by the same rupture which produced the western Alps. At this period, an immense pressure appears to have been created under the peninisula, which elevated it to its present position, and projected crystalline rocks or *ophites* through its substance. Hence it is, that we find these rocks in mountains of different ages, and that the latter affect an east north-east direction. which characterizes the elevation at this period. The great snowy chain which separates the two Castiles, the Sierra Morena, presents the character of mountains formed successively, and then re-united at a more recent period by another eruption. The latter are composed of three distinct parts, in relation to the stratification of the rocks and its direction. This revolution formed the Spanish Alps, the Sierra Nevada, and the coast between Malaga and Gibraltar. By raising the Southern coast of Spain the lands which united the latter with Africa were lowered, and the Strait of

Gibraltar was formed at the time that the elevation of the tertiary strata of France destroyed the ancient strait, and joined Spain to the continent of Europe. The recent date of this dislocation is confirmed by the direction of the ophites, and the similarity of the plants and animals as observed by Bory de Saint Vincent on the opposite coasts of Africa and Spain.

ARTICLE IV.

Experiments and Observations on Visible Vibration.

By CHARLES TOMLINSON, Esq.

> "The subject is far from being exhausted; and, indeed, there are few branches of Physics which promise at once such amusing interest and such important consequences in its bearings on other subjects."—HERSCHEL.

1. THE principal object of Philosophy is to explain as much as is known of the code of laws by which the material universe is governed, and to discover those laws which have hitherto eluded the search of Philosophers.

2. As a discoverer of a law of Nature is more worthy than an expounder, the votaries of modern Science have been and still are engaged in promoting the dignity and happiness of man, by increasing efforts to extend the boundaries of knowledge by a more familiar acquaintance with Nature's Book; with a code of laws which we are bound to consider perfect in all respects, and commencing its operations at a time when man first began to inhabit this globe: so that, when we hear of the discovery of a *new* law, we must not refer its novelty to Nature, but only to ourselves. Human laws may be created, modified, and changed to suit new emergencies, but every occurrence in Nature is referable to a law which has existed, at least, as long as man himself.

3. But philosophers disagree! Yes; and they do so because the law on which they differ is imperfectly explained, or not understood. As soon, however, as the law is well appreciated, all doubts and difficulties are removed; for it, in common with other physical laws, is reduced to a proposition remarkable chiefly for its exquisite simplicity.

4. Among the Sciences which have been advanced more or less towards perfection, the Science of Sound seems to have shared an uncommon neglect, and, considering its high importance, we are naturally surprised that no systematic work, including details and recent discoveries in the Science, exists. Many Philosophers of high character have of late years added much, but their results are still confined to the journals in which they first appeared, and most cordially ought we to desire that some master mind would devote itself to a full developement of this beautiful science.

5. I believe that Chladni, a German philosopher, about the year 1787, first propounded the general law, that, in order to produce a musical note from a glass containing a liquid, both glass and liquid must vibrate in unison as a system. It will be seen, however, in the course of these experiments, that this law (if such it be) is by no means universal in its application.

6. Chladni also first rendered vibration visible, and reduced visible vibration to a system. His method consisted in strewing sand on glass plates, which, when vibrated, caused the sand to arrange itself into various beautiful forms; and, by means of experiment and calculation, he constructed tables of them, which have since been extended considerably by Wheatstone and others.

7. If a glass containing water be vibrated by moving a moistened finger round the edge, the water will undulate, but the form of the undulæ will not be very distinctly seen on account of the length and transparency of the fluid. Now, it occurred to me that by employing a denser fluid the figures would be stronger, and better defined.

8. I accordingly poured about a fluid ounce of mercury into a foot glass, and, as soon as the note was produced by moving the moistened finger round the edge of the glass, the mercury assumed a very beautiful appearance. A series of concentric circles or bands of undulæ were formed, the centre of the mercury being the common centre of the whole, round which centre a star appeared to revolve in the direction of the finger, the radii of the star seeming independent of the undulating bands. Within these bands there also appeared a square figure with rounded corners, which may be very distinctly seen by twilight, where the

undulæ reflect the light well, and the space within this rounded square does so imperfectly. I should also observe that the surface of the mercury resembled for the most part the case of an engine-turned watch, and the apparent revolution of the star was in the direction of the finger, from right to left, or from left to right, and the number of the radii seemed to depend on the rapidity with which the finger was passed round the edge of the glass, as well as on the size of the vessel used, and the extent of the mercurial surface.

9. Now, it is known that a body, a foot glass, for instance, in sounding, contains a certain definite number of nodal points or divisions, the vibrating portions between the divisions performing their vibrations independently of each other. These nodal points are points of rest, or at least, of minimum vibration, and the parts of the mercurial surface, which are comparatively quiescent during the vibration, are lines which pass from the circumference to the centre of the mercury, while the undulating rings, being in motion, give an apparent motion to the star formed by the nodal lines.

10. Dr. Thomas Young, in his Lectures on Natural Philosophy, (vol. i. p. 385.) states, " that a vibrating glass or bell divides, in general, into four portions vibrating separately, and sometimes into six or eight; they may readily be distinguished by means of the agitations excited by them in a fluid contained in the glass." Now, I have observed several and I think better modes of discovering the nodes in a glass or bell. For instance; procure* two foot glasses, as perfectly in unison as possible, and about three inches in diameter; place on the glass, the nodes of which are to be ascertained, a piece of very slender copper wire, terminated at each end with a sort of half loop or hook, so as to be free to move in the plane of the circle described by the rim of the glass, and yet not to fall off during vibration. Place the glasses on wood, or other good conductor of sound, and vibrate with the moistened finger

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* If two unisonant foot glasses cannot be procured, or if it be inconvenient to accord them by water or mercury, the wire can be placed on one glass, and the vibration produced by passing the moist finger round the exterior half, and the result will be the same.

the first glass; the wire on the second will vibrate strongly, and seek the nearest nodes and remain there. These two nodes are of course exactly opposite to each other, and may be marked with a dot of ink on the side of the glass immediately below. The two other nodes are midway down, as may be seen by moving the wire away from the two first nodes, so as to be within the sphere of attraction (if I may so speak) of the two second; the wire will almost immediately attain those two points, and if the finger be slackened in its pressure, so as to produce a clear but not a full note, in order that the wire may not be jerked, and the finger be then removed, the wire will invariably rest on the nodal points.*

11. Various forms of wire may be adopted; a half circle terminated with loops or hooks; or a right angle, the sides of which simply rest against the glass, while the apex points towards the bottom of the glass; or what, perhaps, is most striking and satisfactory of all, four curved pieces of wire, resembling ladies' hair pins, only with very short legs, may be employed, one leg within and another without the glass. On placing these midway between each of the four nodes, and vibrating the unisonant glass, the wires will find out the nodes and continue to vibrate there.

12. I need not, of course, remark that the nodes are not always, strictly speaking, at four equidistant points of the same circle. One direction may contain more or less matter than another, and when this is the case to an appreciable extent, there will be an interruption in the vibration. For instance: I find *that in foot glasses, the rim of which is about three inches in circumference, there are always four nodes which are, or ought to be, equidistant;* if this be not the case, the space between the first and second node will vibrate quicker or slower than the space between the second and third, and so on. Now, if one space vibrate 100, and another 101 times in a second, there will be an interference, and, consequently, a momentary interval of silence. This may be observed in a foot glass under the circumstances before mentioned; if the note be produced by the moistened finger,

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* I should observe, that if, when the wire is vibrating at the node, one end be moved away a little from that point, it will instantaneously regain the node, as if it were a metallic spring.

and then removed, and the ear be applied close to the glass, the note will be distinctly heard to consist of such sounds as

woo, *woo*, *woo*, *woo*, *woo*,

and so on until all vibration ceases.

13. In my early attempts to ascertain the nodes by means of wire, I observed a very curious effect: I had employed a piece of iron wire, entirely free from magnetism, placed one end at the bottom of the glass, and the other resting against the side. On vibrating the glass containing the wire, I found that it invariably turned towards the north, and continued to vibrate there in the plane of one magnetic meridian. I employed copper and brass wire, always *without* the same effect. I therefore assured myself of the correctness of the first experiment, and got two or three friends to repeat it, but the result was undoubted. I even found that the result was obtained when the glass was half filled with water or oil, so as to cover the wire, and that the motion of the wire, and its retention towards the north, seemed facilitated by that fluid.

14. In explaining this experiment I must refer to the mode of inducing magnetism by percussion, such as an inclined poker or bar of iron when struck by a hammer. The blows strongly vibrate every particle of the mass of metal, and, by a process not clearly comprehended, magnetism is induced. Now, in the above experiment, vibration, by a somewhat analogous process, renders the wire slightly magnetic, and being free to move, it is of course attracted by the magnetic force.

15. To return, however, to the vibrating mercury, we must consider that as the vibrating parts of the glass act at right angles to the mercury, the edge of that fluid is, as it were, attracted and repelled, and the the first band of undulæ moves in the direction of the finger, as may be shewn by placing a small shot or other small body on the mercury, leaning from its convex edge against the side of the glass. The attractions and repulsions that I speak of may be illustrated by surrounding the mercury with a circle of small shot at the circumference. If the glass be then vibrated the shot becomes agitated in a singular manner. All seem actuated by a uniform vibrating motion, and the

sound produced by the shot is of a peculiar kind; their vibration even continues for some seconds after the finger is taken from the glass, in consequence of the momentum they and the glass have acquired, and the note gradually becomes more acute and faint.

17. If a large glass be employed in the above experiment, (15) and the finger be well moistened, and in its rotation pressed rather heavily on the edge of the glass, so as to produce a strong full noise, some of the shot will start from the circumference to the centre, and there remain in a state of rest. Indeed, the tendency of globular bodies is to the centre, where they remain in a quiescent state.

18. A totally different appearance can be communicated to the surface of the mercury, by moving the finger, not in continued order round the glass, but with a jerking kind of motion, pressing heavily, and resting for a moment at intervals of about an inch. The mercury is then thrown into broad concentric circles, sometimes perfect and sometimes broken.

19. The mercury can also be made to assume a variety of forms, according to the mode of vibrating the glass, and the quantity of mercury employed, by drawing a bow against the edge or edges of the glass; by pressing the finger more or less heavily; or by passing it round with greater or less rapidity.

20. When the mercury is very clear the edge of the glass will be seen distinctly reflected in it; if a large soda water glass be employed, and the finger moved slowly round, the reflected edge will be seen thrown into a series of nodes and ventral segments. The forms are very various and interesting, and depend on the circumstances just mentioned (19.) If the mercurial surface be covered with a thin coating of oil, the edge may still be seen distinctly reflected, but it is not disturbed during vibration. (23.)

21. The glass below the mercury vibrates but little, nor does the mercury vibrate much below its surface; for the hand can be placed round the inside of the glass below the surface of the fluid, and the vibration of both seems unaffected, except that the note does not sound so full or so clear.

(22.) The same observation applies when gelatinous and oleaginous substances are employed instead of mercury, except that they do not vibrate.

23. I now proceed to notice the effects of this method of vibration on other fluids, and their effects on mercury. *The fixed oils and sulphuric acid, I find, will not vibrate, and when poured on the surface of mercury they entirely prevent its vibration.*

24. I attribute this preventive effect to the consistency of those fluids, for muriatic acid vibrated and permitted the mercury to vibrate. Nitric acid also vibrated, and its decomposition seemed retarded by the vibration. I could not distinguish whether the mercury vibrated; but when two drachms of acid were diluted with the same bulk of water, both dilute acid and mercury vibrated readily.

25. When oil is poured on the surface of the mercury, the vibration of the latter may be restored by the addition of water; the oil rising to the surface of that fluid allows the mercury to vibrate. If, however, oil of cloves be employed, or any oil of greater sp. gr. than water, the water will remain on the surface and vibrate, while the two strata of fluids below remain quiescent; but, if sulphuric acid be diluted with about its own bulk of water, it will vibrate and allow the mercury to vibrate also.

26. At a temperature of 238° olive oil vibrates, or rather undulates at or near its circumference, but all motion soon ceases as the temperature falls.

27. Sperm oil at 340° vibrates as readily as water; its ready vibration decreases, of course, as the temperature falls, and at about 180° its vibration ceases.

28. Sperm oil at 300° poured on mercury at the atmospheric temperature vibrates, and allows the mercury to vibrate as effectually as if it were but water. The temperature of the oil rapidly decreases, in consequence of absorption of heat by the mercury and radiation, but the most singular part of this experiment is, that after the oil has ceased to vibrate, the mercury vibrates readily, and turns the oil round at a temperature so low as 80°, and a needle placed on the surface of the mercury beneath the oil, turns slowly round in the direction of the finger, as also small shot at the circumference.

29. Castor oil at 368° vibrates, but not readily. On

adding about an equal bulk of mercury the temperature fell to 190°, when both oil and mercury undulated a little, but all motion ceased in a minute or two as the temperature fell.

30. A compound of castor oil and alcohol did not vibrate.

31. Rape oil, at the ordinary temperature of the atmosphere shews not the slightest indication of vibration; nor indeed, do any of the oils at ordinary temperatures (23) but rape oil at 310° undulated at the circumference. On adding about an equal bulk of mercury, the temperature fell to about 140°, and both fluids undulated at the circumference. A needle on the mercury beneath the oil was quite unaffected. At 126° not the slightest motion was apparent in the oil.

32. Linseed oil at 367° undulates freely and swims narrow slips of writing paper round in the direction of the finger. The paper, however, soon sinks, shewing the small sp. gr. of the heated oil.

33. Sulphuric acid, (sp. gr. 1·839) was heated to 239°, when it vibrated almost as readily as water. After a short time, about an equal bulk of mercury was added and the temperature fell to 95°, but neither fluid vibrated.

34. The muriatic, nitric, acetic, and pyro-ligneous acids are good vibrators, the two latter even better than water. A narrow slip of writing paper placed on the surface of either of the two latter, is borne round quickly in the direction of the finger

35. A mixture of sulphuric acid four parts, and alcohol one part, vibrates well.

36. The saponaceous compound, procured by adding liquor ammoniæ to oil and water, does not vibrate.

37. I have already noticed the proposition of Chladni, (5) that in order to produce a musical note from a glass containing a liquid, that both glass and liquid must vibrate together in unison as a system. Now in the above experiments, *whether the liquids that I used vibrated or not, I always procured a full, clear, musical note from the glass; from the densest oil that I employed, which was castor oil, to the most limpid sperm oil.* I have even found, contrary to the general and received opinion, *that a glass containing a liquid in a state of active effervescence, will yield a full and*

clear musical note by passing the moistened finger round the edge of the glass, as has been done in all these experiments.

If to dilute nitric acid, sufficient to half fill a large soda water glass, three or four lumps of carbonate of ammonia be added, an active effervescence will of course ensue; but the same strong, clear note can be produced during the most active effervescence, when small bubbles of carbonic acid rise more than half an inch above the surface of the liquid, and the only difference worthy of remark is, that the moment the finger is removed from the glass the note ceases; whereas, with the oils and other liquids, whether they vibrate with the glass or do not vibrate at all, the note continues audible for a few seconds after the finger has left the glass.

38. In the last experiment if the glass be struck it will not, as Chladni says, *ring*. This striking is, however, at best, but a very imperfect mode of vibrating a glass. It is necessary that every part of the circle should receive an impulse, which it can only do by the moistened finger. If, however, the liberation of carbonic acid be such as to cause bubbles of gas to rise up to the brim, the vibration will certainly be deadened; as when a saturated solution of carbonate of soda is contained in the glass, if a saturated solution of tartaric acid be added, the liquid will rise up and interrupt the vibration, but if the acid be added in lumps, the note will be uninterrupted.

39. I now proceed to notice the effects of solids placed on the surface of the vibrating mercury. I placed upon it a small magnetic needle, and as soon as the note was produced by means of the moistened finger, *the needle revolved in a contrary direction to the finger, and contrary to the apparent motion of the star*, (8.)

40. I then employed a two inch bar magnet, and this during vibration, assumed a position east and west, as the finger was moved from left to right, and west and east as the motion of the finger was reversed.

41. I found, however, that unmagnetised iron wire revolved in an opposite direction to the finger, and as I saw nothing in the experiment (40) to induce me to believe that electricity was induced, I concluded that the efforts of the bar magnet, which was a powerful one, to regain its

natural direction, prevented the vibrating force from bearing it round beyond east and west and west and east.

42. With impure mercury I found the motion of the needle or wire much retarded, and on covering the surface of clean mercury with a very thin coating of lycopodium dust, the motion of the needle was altogether suspended.

43. I found pieces of wood, cork, paper, cotton, wool, camphor, camphor in a state of ignition, a silver amalgam, &c., all to follow the same general law of revolving, contrary to the direction of the finger.

44. I therefore, began to inquire, whether there might not be opposing currents in the vibrating mercury, which had hitherto escaped my notice, as indeed, was likely to be the case, as the time that I could devote to this investigation, out of an absorbing and anxious profession was so limited, that I could only work by artificial light; and I afterwards found that in order to detect minute appearances, a good natural light was indispensable.

45. I need not now detail the various experiments which led me to the conclusion, that what I had suspected, was really the case: *that in vibrating mercury there is a series of concentric currents; that the outer current revolves in the direction of the finger, but there are inner currents revolving in an opposite direction, the number or force of which, is greater than those which revolve in the direction of the finger.*

46 In a second paper, I shall resume this subject. I must, however, observe, that in performing these experiments, the mercury should be perfectly clean and free from amalgam; and that in manipulating with the heated oils, foot-glasses of about 3 inches diameter should be employed and procured as thin as possible. The oils can be heated in a Florence flask with the neck cut off to allow free evaporation to the water contained in them. The glasses must be heated first, and the oil poured in very gradually; the temperature is then to be noted, and the glass vibrated the moment after. By this method, the glasses, if well annexed, will bear a temperature of from 300° to 400°. It is adviseable also to place the whole apparatus in a small tray, in case of fracture either of the flask or glass.

Brown Street, Salisbury,
28*th February*, 1835.

Article V.

On the Adjustment of the Eye to Distinct Vision at Different Distances. By John Walker, Esq. Assistant-Surgeon to the Manchester Eye Institution.

The adjustment of the eye to the distinct vision of objects at various distances, is a question which is still considered to remain undetermined.

It is not my purpose to enter into a history of the various explanations offered, but rather to point out a very simple experiment, which, I think, elucidates the point in dispute. I may, nevertheless, first observe that it is generally admitted that when the eye, from contemplating an object at some distance, suddenly fixes itself on some other object very near to the organ, there is a contraction of the pupil always accompanying this change.

From this circumstance many have been led to believe that the alteration in the size of the pupil is the chief, if not the sole, change which occurs in the eye during this operation. Sir David Brewster has related experiments which are easily verified, and which prove that the application of a bright light to the eye, causing a contraction of the pupil, enables the organ to adjust itself to distinct vision at a less distance than before. Dr. Wells has also established the fact that when the pupil is dilated by belladonna, the power of adjustment is lost. It is also well known that when an object is brought so close to the eye as to be invisible, by looking at the same object, at the like distance, through a a pin-hole perforated through a card, it becomes quite distinct. All these circumstances seem to favour the opinion that it is merely the size of the aperture, through which the rays of light are admitted into the eye, that regulates the adjustment; but still they are considered fallacious, and it is thought that some alteration in the refracting media is indispensable.

It occurred to me, whilst debating these facts in my mind, that, with an artificial eye-ball, which I possess, fitted up with a cornea, iris, lens, and a retina of ground glass, each bearing its proper relation to the others, by varying the size of the pupillary aperture, we might discover whether any other action, besides that of the pupil, was necessary to effect the change in question. With this instrument the following observations were noticed. The pupil being of a moderate size, a small object, placed within a few inches of the cornea, was represented on the retina in a very shadowy and indistinct manner. On contracting the aperture, which was done by covering the iris and pupil with a piece of black riband, perforated in the centre, the picture of the object appeared beautifully clear and well defined. Now, here there could be no vital action, no change in the figure or position of the lens, nothing but the alteration in the dimensions of the pupil, and yet the desired effect was produced in the most satisfactory manner. With the same instrument, it is demonstrable, that if the lens be removed, and the pupil remain of the natural size, no object whatever will be represented on the retina; but, with a contracted pupil, and the lens still absent, a very fair outline of any object will be clearly and distinctly seen.

Experiments of all sorts, I am well aware, generally appear more determinate and conclusive to their authors than to indifferent individuals; and, when they are anxious to establish any particular theory, they do not easily see objections, which to others are sufficiently apparent. It is therefore not unlikely that I may have overrated the importance of these experiments, when I say that, to me, they appear to settle the point at issue. If, however, I shall have arrived at an unsound conclusion, I must then throw myself back on the novelty and interest of the facts as my only apology.

ARTICLE VI.

Account of some new Species of Minerals containing Barytes.

By THOMAS THOMSON, M.D., F.R.S., L. and E., &c., Regius Professor of Chemistry in the University of Glasgow.

THE species of barytes minerals hitherto described by mineralogists are but few in number. The sulphate and carbonate have been long known. When to those we add the baryto-calcite of Brooke, and the stromnite of Dr. Trail, together with harmotome and brewsterite, we enumerate almost all the species of minerals containing barytes at present known. Having, during an examination of the mineral kingdom, in which I have been occupied for the last eight years, met with several other minerals containing barytes, and differing specifically from those already known, it may, perhaps, be acceptable to mineralogists if I give a short account of the most remarkable of those in this place.

1. *Calcareo-Sulphate of Barytes.*—This species, though hitherto overlooked by mineralogists, occurs rather abundantly in the lead mine of Strontian. This mine, as has been long known, constitutes a vein in a mountain, consisting partly of granite and partly of gneiss, and the vein divides the granite portion from the gneiss. The gangue of this vein consists of carbonate of lime, carbonate of strontian (towards the bottom,) sulphate of barytes, harmotome, calcareo-sulphate of barytes, &c. This last mineral probably has been overlooked, because it never occurs in the state of crystals.

Colour, snow white; texture, foliated; very frangible; translucent on the edges.

Hardness, 2·75 on Mohs's scale; specific gravity 4·1907. Before the blowpipe decrepitates, but does not fuse. When subjected to analysis I obtained the following constituents:

		atoms.	
Barytes	48·945	5·15	7·15
Strontian	0·790	0·12	
Lime	6·605	1·88	
Sulphuric acid	35·230	7·04	
Silica	4·140	2·07	
Alumina	3·460	1·53	
Protoxide of iron	0·450	0·10	
Moisture	0·565		
	100·185		

We see that the sulphuric acid almost exactly saturates the barytes, strontian, and lime. From this it can scarcely be doubted that the other constituents are merely accidentally present, and do not constitute an essential part of the mineral.

If we include the strontian with the lime, the mineral is obviously a compound of

2 atoms sulphate of lime
5 atoms sulphate of barytes
or (which comes to the same thing)
1 atom sulphate of lime
2½ atoms sulphate of barytes.

The probability is, that this mineral has been hitherto confounded with sulphate of barytes. When we find the specific gravity of that sulphate stated as low as 4·2984, as it is by Haüy, or 4·136, as it is by Hoffmann, there can be little doubt that the specimen examined was, in reality, a calcareo-sulphate.

2. *Baryto-Calcite.*—I have given this name, perhaps improperly, (as Brooke had already appropriated it to another mineral) to another species of calcareous sulphate of barytes, which occurs in Yorkshire, between Leeds and Harrogate, connected with the millstone grit and mountain limestone which occur in such abundance in that country. But I state this as the situation solely on the authority of the mineral dealer from whom I purchased the specimen.

Colour, white, with a slight shade of blue; texture, foliated; translucent when in thin plates; lustre, silky; hardness, 4·; exceedingly brittle, and very easily frangible. Specific gravity 3·868·

Its constituents, by my analysis, are

Sulphate of lime . .	71·9	or 4½ atoms.
Sulphate of barytes .	28·1	,, 1 atom.
	100·	

The foreign matter amounted to about 1½ per cent. It consisted of ironshot sand, probably introduced by the infiltration of water.

3. *Sulphato-Carbonate of Barytes.*—This mineral occurs in Brownley Hill mine, in the County of Cumberland. I first saw it in a collection of minerals exposed for sale in Glasgow in November 1834, by Mr. Cowper, a mineral dealer from Alsten Muir. Colour, snow white.

The specimen consists of a cengeries of very large six-sided prisms, terminated by low six-sided pyramids. The surfaces were so rough and irregular that it was impossible to measure the angles, even with a common goniometer. The only angle of the prisms that it was possible to try, measured about 130°, shewing that the prism could not be regular. Three cleavage planes were rather obscurely perceptible They were parallel to the faces of an obtuse rhomboid, which seemed to meet at angles of about 100° and 80°.

Texture, foliated; lustre, vitreous; translucent; hardness about 3· ; specific gravity 4·141.

On subjecting it to analysis I obtained

		atoms.
Sulphate of barytes . .	34·30	- 1·
Carbonate of barytes . .	64·82	- 2·2
Carbonate of lime . . .	0·28	
Moisture	0·60	
	100·00	

From this analysis I think it probable that the mineral is a compound of

1 atom sulphate of barytes.
2 atoms carbonate of barytes.

Sp. 4. *Calcareo-Carbonate of Barytes*.—I give this name to a mineral first described by Mr. Brooke,* and called by him *baryto-calcite*. This name I could not adopt, for a reason that will appear when the next following species is described.

It exists in considerable quantity at Alsten Müir, in Cumberland, both crystallized and massive.

Its colour is white, with a shade of gray, yellow, or green. Cross fracture, uneven or imperfect and conchoidal.

The primary form of the crystal is an oblique rhombic prism.

Pon M or M′ 102° 54′
M on M′ 106° 54′

The obtuse edges of the prism are almost always replaced by tangent planes.

Lustre, vitreous, inclining to resinous; varies from translucent to transparent; hardness 4. Specific gravity, as determined by Mr. Richardson in my laboratory 3·6363.

Before the blowpipe it does not fuse *per se*, but melts easily with borax and biphosphate of soda into a transparent glass.

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* Annals of Philosophy, (Second Series) viii. 114.

Its constituents, as determined by Mr. Richardson in my laboratory, are,

		atoms.
Carbonate of barytes	62·20	- 5·077
Carbonate of lime	31·65	- 5·064
Sulphate of barytes	0·30	
Peroxide of iron	0·85	
Water, or volatile matter . .	3·15	
	98·15	

It is obviously a compound of

1 atom carbonate of barytes.
1 atom carbonate of lime

Sp. 5. *Bicalcareo-Carbonate of Barytes.*—This mineral was (among others) exposed for sale in Glasgow in November 1834, by Mr. Cowper, a mineral dealer from Alsten Muir. I purchased a specimen, and subjected it to chemical analysis, because it appeared to be new. Colour, snow white.

Crystallized in beautiful dodecahedrons with triangular faces, composed of two six-sided pyramids applied base to base. The faces were not bright enough to admit of measuring their inclinations to each other. The inclination of a face of one pyramid to the corresponding face of the other was about 132° and the angles of the plane separating the two pyramids were about 120°. Only a single cleavage could be observed.

The crystals were in groups, upon a white crystallized substance, which I did not analyze, but it had the aspect of sulphate of barytes.

Lustre, vitreous; cross fracture, uneven; some imperfect appearance of a foliated structure; translucent; hardness 2·25. Specific gravity 3·718.

When dissolved in nitric acid it left 0·75 per cent. of sulphate of barytes. The moisture, which rather exceeded 2 per cent., was doubtless hygrometrical. Abstracting these bodies, which I considered as foreign, the constituents were

		atoms.
Carbonate of barytes . . .	49·31	or 4·02
Carbonate of lime	50·69	,, 8·01
	100·	

This is obviously

1 atom carbonate of barytes.
2 atoms carbonate of lime.

Thus, it contains exactly twice as much carbonate of lime as the baryto-calcite of Brooke, though the constituents of the two minerals are the same. It was the necessity of having names by which these two minerals could be distinguished from each other that obliged me to alter the name imposed by Brooke, and to adopt the terms *calcareo-carbonate, and bicalcareo-carbonate of barytes.*

Sp. 6. *Baryto-Sulphate of Strontian.*—This species is found in Drummond Island, in Lake Erie, and also at Kingston, in Upper Canada. I got specimens from the former locality from Major Menzies, and from the latter locality from Dr. Holmes of Montreal.

The colour is white, with a very slight shade of blue.

The texture is laminated, and the laminæ, which are obviously imperfect crystals, diverge so as to form a kind of pencil.

Brittle; very friable; hardness 2·75. Specific gravity 3·921.

Before the blowpipe in the platinum forceps, becomes of a dazzling white, but does not easily fuse. Melts readily with carbonate of soda into a transparent colourless bead, which becomes white and opaque on cooling. With borax it fuses easily into a white opaque globule.

Its constituents are

		atoms.	
Sulphuric acid . . .	40·202	8·04	10·
Barytes	23·059	2·43	3·02
Strontian	35·724	5·49	6·82
Protoxide of iron . .	0·588	0·13	0·16
Water	0·720		
	100·360		

This is obviously equivalent to

3·02 atoms sulphate of barytes.
6·82 ,, sulphate of strontian.
0.16 ,, sulphate of iron.

Including the sulphate of iron with the sulphate of strontian, we have for the constitution of this mineral

3 atoms sulphate of barytes.
7 ,, sulphate of strontian.

Sulphate of barytes and strontian are met with combined in other proportions. I have seen three other species described, but not having any of them in my cabinet, I have not had it in my power to subject them to analysis. But they have been analyzed by Dr Turner, and M. Gruner of Hanover, and found composed of

	atoms.	atoms.	atoms.
Sulphate of barytes . .	1	2	5
Sulphate of strontian . .	5	7	2

ARTICLE VI.

On Human Saliva. By C. G. MITSCHERLICH. (*Poggendorff's Annalen*, xxvii. 320.)

A MOST important object in the analysis of animal secretions is to obtain them in a pure state. In the case of the saliva it is obvious that there are numerous difficulties in the way of procuring that fluid free from the substances which may accidentally find their way into the mouth, either from the food after mastication, from the œsòphagus, or from the mucus surfaces. In order to avoid the mixture of foreign matter which it must necessarily meet with in the mouth, the best method would be to procure it externally from the parotid gland, either by means of an artificial incision, or during the occurrence of a salivary fistula. It was in the latter way that Mitscherlich obtained the saliva which he subjected to examination. The saliva flowed out by an opening half a line in diameter, at the third grinder of the upper jaw, on the left side, the mouth of the parotid duct being completely closed up. The patient, who was about 41 years of age, was not much affected, so far as regarded his general health, except that some degree of emaciation was present. Digestion remained regular. The urine was acid; the perspiration natural, and the dejections as usual.

The method hitherto employed to determine the quantity of saliva secreted by the glands, was to estimate that contained in the mouth, a mode which was liable to great objections; but when the saliva of the parotid gland was all evacuated by an opening in the cheek, the proportion of the secretion under different circumstances was easily ascertained.

Mitscherlich found that the secretion is diminished by passions of the mind, by perfect rest, and is always increased by the motion of the lower jaw, and by coughing. During mastication, and in the act of drinking, the saliva is separated in abundance, and often collects in drops. At the commencement of mastication the saliva was stronger both in regard to chemical composition and consistence, than towards the termination. During the night the quantity of saliva was very small, as might be expected, when the motions of the under jaw, of the tongue, as well as the nervous action on the salivary glands are no longer stimulating the secretion.

The quantity collected in an apparatus provided for the purpose, and properly adjusted, from 8½ P.M. to 5 A.M. amounted to 0·748 grm. (11½ grs.) After breakfast, between 8½ and 12 A.M. 1·862 grm. (19·1 grs.) of saliva were obtained. The same experiment repeated gave in about three hours 1·242 grm. (29·2 grs.) In the course of four hours in the afternoon, 1·9 gr. were procured, during which period and that in which the previous experiment was made, the patient spoke a good deal. During mastication the experiment upon the quantity of saliva secreted were so often repeated that Mitscherlich considers the point completely settled.

The smallest quantity procured during three meals was 46 grm. (708· grs.) the greatest quantity 74·5 grm. (11·47 grs.) but, in addition to these regular repasts, the patient drank twice daily a cup of tea, when 5 or 6 grms. (77 grs.) passed through the fistula.

In this individual, therefore, with the usual diet of the hospital, which consisted of water gruel and wheat bread to breakfast, broth, beef, pulse, and bread to dinner, and water gruel and bread in the afternoon, the amount of saliva excreted in the 24 hours may be reckoned at between 65 and 95 grms. (1001 grs. 1463 grs.)

Mitscherlich endeavoured to ascertain the quantity of saliva derived from the other salivary glands, and for this purpose he caused the patient to spit into a glass vessel during a given time. In 15 minutes the quantity in the glass was 6·27 grms. (96½ grs.) and that derived from the fistula 0·92. (14·16 grs.) the insoluble portion of the liquid from the mouth being separated by filtration. This experiment is not satisfactory, however, because the parotid is the largest gland, and the other five glands yield more than six times the quantity of fluid secreted by it.

With regard to the effect of different kinds of food in increasing the quantity of saliva, Mitscherlich found great difficulty in experimenting with precision, but every one knows the disparity between soft and hard bodies in producing saliva. Mitscherlich estimates the effect of the former to the latter as 3 to 5.

Chemical nature of Saliva.—The saliva in the mouth acts upon tests very variously, being generally slightly acid, often neutral, and sometimes alkaline. The cause seems to be that the saliva remains in contact with the mucus, which is separated from the mucus glands in the mouth. The saliva from the fistula which was exempt from the mixture was alkaline during mastication, and acid at other periods. Twice, however, shortly before eating, the saliva was found to be slightly alkaline, and immediately after eating it was perceived to be still alkaline, but remained so only for a short time. When the saliva was drawn into the mouth by the exertion of the patient it was observed to be slightly acid. In this case the saliva from the fistula was neutral, or scarcely acid. The saliva in the mouth often indicated a free acid, and in the instance where the saliva from the fistula was acid, the saliva of the mouth was completely neutral. Mitscherlich was inclined to attribute this to the chemical combination of the saliva with the mucus, by which ammonia was extracted.

During eating and drinking the saliva was invariably alkaline, for after the first mouthful the acid disappeared. and *reddened* litmus paper became blue.*

Specific gravity.—Tiedemann and Gmelin found the density of saliva produced during the smoking of tobacco 1·0043. In Mitscherlich's experiments it varied from 1·0061 to 1·0088, but when collected during the usual hospital dinner, its specific gravity was almost constant at 1·0074. He found also, that the specific gravity was greater, in proportion to the cessation from eating.

The density of the saliva in the trials of Tidemann and

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* These statements are at variance with those of Dr. Donné, (Ann. de Chim. lvii. 402.) who affirms, that the saliva is always alkaline in the healthy state, but that he has found it possessing an acid re-action in diseases of the stomach, especially in *gastritis*.—Edit.

Gmelin was greatly underrated, because they employed a fluid which was produced by the stimulus of tobacco smoke, and was mixed with the *secretion* of the mucus membrane of the mouth.

Action of re-agents.—Saliva from the fistula was not quite clear, for it contained some white flocks, which after standing for some time sunk to the bottom of the vessel, and were then separated in greater abundance from the fluid. This first substance does not appear to belong to the saliva, but seems to be derived from the mucus membrane of the parotid gland and duct, as well as from the peculiar membrane of the fistula. When the saliva is filtered this substance remains on the filter. 29·797 grms. (458·8 grs.) of fresh saliva are mixed with 0·0015 grm. (·023 gr.) of the matter: 24·955 grms. (384·2 grs.) gave in another trial 0·019 grm. (0·29 gr.) This substance is insoluble in water, alcohol and acids, dissolves in potash, out of which solution it is precipitated by acids, and has when dried a brown colour. Its chemical properties seem to indicate, that it is not chemically combined with the saliva, but mechanically mixed with that fluid.

The filtered saliva is quite clear; more or less of a yellowish colour; not mucilaginous; alkaline and of the density already given. After standing for some time, a whitish mucus like substance separates which is insoluble in water, alcohol and acids, dissolves easily in potash, and is partly precipitated out of this solution by acids. This substance will be noticed in the sequel.

Alcohol produces in pure saliva a white precipitate, which by heating is partly dissolved, but on cooling again falls down.

The precipitate with nitrate of silver is easily soluble in ammonia.

Tincture of galls occasions a clear brown precipitate, which dissolves by the application of heat, but re-dissolves when the liquid is allowed to cool.

Acetate of lead forms a copious white precipitate which does not dissolve by heating, but disappears by an excess of acetic acid.

Sulphuric acid gives a slight flocky precipitate; caustic potash and ammonia produce no visible effect.

Quantitative analysis.—The quantity of free alkali was determined by the addition of sulphuric acid. 29·797 grms. (458·8 gr.) of saliva of the specific gravity 1·0070 required for complete neutralization, 0·0925 grm. (·416gr.) sulphuric acid of the sp. gr. 1·816=0·066 grm. (1·016 gr.) common sulphuric acid. Hence, 100 parts of saliva take 0·223 grm. (3.43 gr.) sulphuric acid for saturation, which neutralize 0·174 grm. (2·67 gr.) soda.

In a second trial 59·594 grms. (917·6 gr.) saliva of sp. gr. 1·0074 required 0·163 (2·5 grs.) sulphuric acid of sp. gr. 1·816=0·117 grm. (1·8 gr.) sulphuric acid, or in 190 parts 0·196 sulphuric acid which saturate 0·153 soda.

When the sulphuric acid is added, a white flocky precipitate falls down, which possesses the properties of the salivary mucus. The first drop of acid produces a muddiness, which as the point of saturation approaches is increased. Hence, it is probable, that as no carbonic acid appears to be extricated, the soda exists in combination with the mucus. This idea seems also to be confirmed by the circumstance, that when the saliva is exposed to the air, carbonic acid is absorbed by the alkali and the mucus is precipitated.

The free alkali is not volatile, for no ammonia was driven off by heating. To determine the quantity of inorganic bases, 47·7997 grms. (768·4 grs.) of saliva of the sp. gr., 1·0075 were treated with nitric acid till all the organic constituents were destroyed. The dry residue amounted to 0·338 grm. (5·2 grs.) which when dissolved in water, left 0·015 grm. (¼ gr.) Muriatic acid dissolved 0·008 grm. (·123 gr.) of this, which after solution yielded a precipitate with ammonia, consisting of phosphate of lime, equivalent to 0·0168 per cent. The portion which was insoluble in muriatic acid was examined by the blow-pipe and found to be silica. That part which dissolved in water amounting to 0·323 grm. (4·97 grs.) was treated with alcohol and chloride of platinum, and precipitated 0·096 grm. (1·47 gr.) of potash =0·209 per cent.

The solution filtered from this precipitate was evaporated; the residue heated to redness and re-dissolved in water. From which 0·17 grm. (2·6 grs.) chloride of sodium was obtained=0·188 per cent. soda.

To determine the quantity of chlorine, 22·224 grms.

(342·18 grs.) of filtered saliva of sp. gr. 1·0081 were mixed with an excess of nitric acid, and precipitated by nitrate of silver. The resulting precipitate amounted to 0·076 grm. (1·17 grs.) chloride of silver=0·084 grm. (1·29 gr.) per cent. of chlorine.

The proportion of phosphoric acid is given under phosphate of lime.

After the saliva has been treated with nitric acid until all the organic constituents are destroyed, a residue remains which is partly soluble in water, and affords a trace of sulphuric acid with muriate of barytes. Saliva contains therefore, muriatic acid, phosphoric acid, and sulphuric acid. The potash being the stronger base is united with the stronger acid, and the free soda being a weaker base, is combined with its appropriate acid. There remain, however, 0.094 potash in 100 parts, and 0·024 per cent. soda to be neutralized by an organic acid. This is lactic acid, which Mitscherlich has not been able to estimate in the direct way.

The salts contained in saliva appear to be

Chloride of potassium	0·18	per cent.
Potash (combined with lactic acid) .	0·094	,,
Soda (with lactic acid)	0·024	,,
Lactic acid		,,
Soda (probably united to salivary mucus)	0·164	,,
Phosphate of lime	0·0174	,,
Silica	0·015	,,

Treviranus considered that the dark red colour which is produced by adding to the saliva muriate of iron, was owing to the existence, of what he called acid of the blood. Gmelin ascribed this property to the presence of sulphocyanic acid. A single drop of the solution of muriate of iron, occasions a dark red colour in a great quantity of saliva. By agitation the mucus separates, and a fine dark red colour is exhibited in the saliva. Saliva from the mouth, gave the same result as the saliva from the fistula, and was the same both in the acid and alkaline states of that fluid.

In the examination of the organic constituents, high temperature is to be avoided, because they are altered by such means. The evaporation of the water and alcohol is to be conducted under the receiver of an air pump. The quantity of the fixed constituents of the saliva, varies slightly in different trials, but is in proportion to the specific gravity.

Saliva of sp. gr. 1·0072 contains 1·468 per cent. of fixed
matter. 1·0079 ,, 1·551
1·0083 ,, 1·632

66547 grms. (1024·7 grs.) of filtered saliva of sp. gr. 1·0079 being neutralized with dilute sulphuric acid, yielded a flocky white precipitate, which when collected and washed on the filter, weighed 0·061 grms. (·93 grs.) The liquid which passed through the filter was evaporated under the receiver of an air pump, and left a residue amounting to 1·051 grm. (16·17 grs.) 0·543 grm. (8·3 grs.) of this matter dissolved in alcohol of sp. gr. 0·863, and the other results after treatment with water and alcohol were,

	grm.	grs.
Insoluble in water and alcohol	0·212	3·264
Soluble in water, insoluble in alcohol . . .	0·357	5·497
Soluble in water, insoluble in absolute alcohol	0·190	2·926
Soluble in water and absolute alcohol . . .	0·340	5·236
	1·099	16·923

66·775 grms. (1028¼ grs.) of saliva of sp. gr. 1·0083 were without being neutralized, evaporated to dryness by the air pump and yielded 1·08 grm. (16·6 grs.)

These were analyzed and gave,	grms.	grs.
Insoluble in water and alcohol (sp. gr. 0·863)	0·281	4·327
Soluble in water and insoluble in alcohol (sp. gr. 0·863.)	0·352	5·420
Soluble in water and insoluble in alcohol (sp. gr. 0·800.)	0·296	4·558
Soluble in water and alcohol (sp. gr. 0·800.)	0·192	2·956
	1·121	17·261

The portion which is not dissolved either by water or alcohol is salivary mucus. Acetic acid swells it up, but does not dissolve any of it either in the cold or by boiling. Sulphuric acid gives it a red tinge, but causes no other change.

Hydro-chloric acid, without heat after a long time, but speedily by boiling, produces a blue solution.

Ammonia acts like acetic acid. Caustic potash produces an imperfect solution.

The matter soluble in water but insoluble in alcohol (sp. gr. 0·863) is called by Berzelius salivary matter. Gmelin made many experiments upon this substance, which differ considerably from those of the Swedish chemist. The salivary matter in neutralized saliva, acts strongly acid upon test paper, but without neutralization, red litmus paper becomes blue in the solution. It is of a yellowish brown colour, but when the alkali is not saturated, and it is kept from the moisture of the atmosphere, the colour is white. The yellowish brown salivary matter dissolves in water, and when carefully evaporated does not re-dissolve, but always leaves a trace of an insoluble substance. The white salivary matter, on the contrary, re-dissolves completely in water after evaporation to dryness. Alcohol occasions a white precipitation which is dissolved by water.

By the application of a strong heat carbonate of ammonia is driven off, and the carbonaceous matter contains potash and soda. No effect is produced upon the aqueous solution of salivary matter by sulphuric, nitric, or hydro-chloric acids, or by ammonia or caustic potash. The same is the case with corrosive sublimate and muriate of iron. Nitrate of silver gives a white precipitate which is re-dissolved by ammonia.

If the salivary matter is obtained without neutralizing the free alkali, then acetate of lead affords a copious white precipitate which does not dissolve by boiling, becomes a slight muddiness by the addition of water, and wholly disappears by an excess of acetic acid. If the saliva is previously neutralized by sulphuric acid, the salivary matter contains sulphuric acid salts, and when the sulphuric acid is removed exhibits the characters already mentioned.

Infusion of galls does not alter the solution of salivary matter.

The matter soluble in water and insoluble in absolute alcohol is no longer soluble in alcohol of sp. gr. 0·863, and consists principally of salts with some animal matter of a yellowish colour. The solution of this substance is not affected by muriate of barytes, corrosive sublimate, muriate of iron, sulphuric acid, muriatic acid, nor by infusion of galls.

Acetate of lead forms a white precipitate which does not disappear on the addition of water, and is not dissolved by acetic acid.

Nitrate of silver produces a precipitate readily soluble in ammonia.

By exposure to a strong heat it affords the product of animal matter, and a carbonaceous substance is left containing potash and soda. It follows, from these experiments, that the substance is identical with the salivary matter, and becomes soluble in alcohol of 0·863, by combining with extractive matter.

The substance soluble in water and absolute alcohol has a yellowish red colour; affords by calcination the same products as other animal substances, and leaves a salt which dissolves in dilute muriatic acid. This salt, when treated with chloride of platinum and absolute alcohol, partly precipitates and partly dissolves, affording in the usual way potash and soda. The properties of this substance can be best observed when the saliva has been neutralized with sulphuric acid, as the extract then contains no dissolved salt. As much water is now to be added as is requisite for the solution of the animal matter, when the crystallized salt dissolves first. The liquid is then decanted from the crystallized salt, and on the addition of muriate of barytes no sulphuric acid can be detected.

This liquid animal substance readily soluble in alcohol and water has a red colour; possesses an acid reaction without containing sulphuric acid, (perhaps lactic acid, which may be obtained in a free state by the addition of sulphuric acid,) and produces no precipitate with acids, potash, ammonia and corrosive sublimate. Acetate of lead produces a considerable white precipitate which dissolves by boiling. Muriate of iron affords a flocky reddish precitate, which does not re-dissolve by adding water.

A precipitation proceeds from the addition of nitrate of silver, which completely disappears by the action of ammonia.

The results of the preceding experiments may be summed up as follows:

1. The separation of the saliva ceases when the muscles and tongue are motionless, and by the absence of the usual nervous stimulus.

2. The quantity secreted depends upon the degree and nature of the nervous stimulus.

3. The secretive organs are excited by the mechanical action of the mouth.

4. The quantity of saliva which is separated from the glands during eating and drinking is very great, and increases with the hardness of the food.

5. From the parotid in the 24 hours from 65 to 95 grms. or from 2 oz. 6 drs to 3 oz. troy, of saliva are separated.

6. Saliva from the mouth proceeding from five glands amounts to six times the quantity from the parotid. The saliva of the mouth, however, contains a considerable quantity of mucus.

7. The saliva during the excitement of mastication or drinking is alkaline, at other times acid.

8. The specific gravity varies from 1·0061 to 1·0088. The causes which occasion these changes are not yet ascertained.

9. The results of analysis are similiar to those of Gmelin and Berzelius, who found it to consist of salts and organic matter.

10. The organic constituents are salivary mucus; a peculiar salivary matter, with the characters which Berzelius has described and extractive matter; a substance soluble in alcohol of the sp. gr. 0·863, when the portion soluble in absolute alcohol remains mixed with it, but insoluble, and possessing the characters of salivary matter after that constituent has been removed.

Article VII.

ANALYSES OF BOOKS.

The Transactions of the Linnean Society of London. Vol. xvii. Part I. 1834.

Contents.—I. Description of the organs of voice in a new species of wild swan (Cygnus Buccinator Richardson.) By W. Yarrell, Esq., F. L. S., &c.

II. Description of three British species of fresh water fishes belonging to the genus Lenciscus of Klein, by W. Yarrell, Esq., F. L. S., &c.

III. Observations on the Tropæolum pentaphyllum of Lamarck, by Mr. David Don.

IV. On the adaptation of the structure of the Sloths to their peculiar mode of life, by Professor Buckland.

V. Observations on Naticina and Dentalium two genera of Molluscous animals, by the Rev. Lansdown Guilding.

VI. Monograph of the East Indian Solaneæ, by C. G. Nees Esenbeck, M. D.

VII. On the Lycium of Dioscorides, by J. Forbes Royle, F. L. S.

VIII. A review of the natural order Myrsineæ, by M. A. De Candolle.

IX. On the Modifications of Aestivation observable in certain plants formerly referred to the genus Cinchona. By Mr. D. Don.

X. Additional Observations on the Tropaeolum pentaphyllum. By Mr. D. Don.

All these papers, with the exception of the two last, amounting to six pages, were read before the Linnean Society in 1832. The quality, however, of the materials of which this volume is composed does not produce the same disappointment which is experienced in reference to the quantity. We may refer more particularly to Esenbeck's Monograph, and the distinguished De Candolle's review, for the materials of both of which we are indebted to the industry of Dr. Wallick and the munificence of the East India Company. It is remarkable, however, that of 145 pages, of which the volume consists, 90 are written by foreigners. I conceive that a short outline of these papers will be highly acceptable to those who may not have an opportunity of reading the transactions themselves.

The paper of Esenbeck treats of two natural orders, viz. Solaneae and Verbascinæ, in reference to Indian species:—

SOLANEÆ.

I. SOLANUM.

1. *Maurella.*

A Pedicles equal to the common peduncle.

1. S Fistulosum.
2. S Incertum *syn* nigrum.

B Pedicles of the fruit, shorter than the common peduncle.

3. S Rubrum.

2. *Geminifolia.*

4. S Spirale.
5. S membranaceum,
6. S laeve.
7. S denticulatum.
8. S bigeminatum.
9. S Neesianum.
10. S crassipetalum.
11. S decemfidum.
12. S macrodon.
13. S lysimachioides.

3. *Verbascifolia.*

14. S verbascifolium.
15. S auriculatum.
16. S giganteum.
17. S vagum.

4. *Melongena.*

18. S melongena.
19. S heteracanthum.

5. *Torva,* (acute lobed leaves.)

20. S Wightii.
21. S barbisetum.
22. S ferox.
23. S torvum.
24. S Indicum.
25. S jacquini.
26. S procumbens.
27. S sarmentosum.
28. S trilobatum.

6. *Nycterium.*

29. S (nycterium) pubescens.

7. *Pinnatifolia.*

30. S tuberosum.
31. S calycinum.

20. Has been named in honour of the indefatigable Dr. Wight of Madras, who for some time has employed painters and collectors at his own expense, for the purpose of elucidating the botany of Madras.

25. Under this species Esenbeck includes the S *diffusum* of Roxburgh. It is an abundant plant in Madras and Bengal, and I have found it occurring plentifully in the neighbourhood of Bombay.

30. This merely refers to the potatoe as cultivated in Madras and Bengal. It does not attain any considerable size in the hot parts of these presidencies, but near Bussorah I believe it thrives much better.

II. LYCOPERSICUM *Dun.*

1. L esculentum. 2. L Humboldtii.

III. CAPSICUM *Linn.*

1. C grossum.
2. C fastigiatum.
3. C frutescens, the *Tschili or Chili.*
4. C chamaecerasus.

IV. PHYSALIS *Linn.*

1. P somnifera
2. P Peruviana.
3. P pubescens.
4. P minima.
5. P angulata.
6. P Indica.

V. ANISODUS *Lin.*

Luridus.

VI. DATURA *Linn.*

1. D alba
2. D fastuosa.
3. D trapezia.
4. D ferox.
5. D stramonium.
6. D tatula.

VII. NICOTIANA.

N tabacum. *Hab.* near Katmandoo.

VIII. HYOSCYAMUS.

H Niger. *Hab.* near Futteghur, Moradabad, Delhi.

VERBASCINAE.

I. VERBASCUM thapsus. *Hab.* near Gossain Than in Nepaul.
2. V Indicum. 3. V *spec. dub.*
II. CELSIA coromandelina. 2. C Viscosa.
III. ISANTHERA permollis.

The paper of De Candolle does not require such a minute analysis as the species of the order *Myrsineæ,* which he has therein illustrated, are all natives of foreign climates, and cannot, therefore, be so generally interesting as those of the order of *Solaneæ.* A few facts may, however, be stated, which exhibit in a striking point of view the rapid progress which botany is at present making in regard the discovery of new species.

The order *Myrsineae* is now placed between the orders *Sapoteae* and *Primulaceae,* from the latter of which it seems to differ in the indehiscence of its fruit, and from the former by the constant deficiency of stamens alternating with the lobes of the corolla. This order is divided by the author into three tribes, 1. Aegicereae, with an erect embryo; 2. Ardisiae, including the bulk of true Myrsineae; 3. Mœseae, with an inferior ovarium, approaching to primulaceae.

He has proposed two new genera, Weigeltia and Conomorpha, and a third, Choripetalum, which has not been sufficiently examined. The species of this order produce a resinous substance, which appears in the form of dots or reservoirs, in different parts of the plant, chiefly on the leaves, flowers, and berries, and also in the hard wood of the Myrsine and Aegiceras. It melts and burns in the flame of a candle, is not soluble in water, but is so in oil or alcohol when moderately heated, giving to the latter a rose colour, These facts were particularly observed in the berries of the *M. semiserrata.* The dots are dark or light brown, reddish or yellow, varying in size, shape and position, in different species. The fruit of *Embelia ribes* possesses a styptic taste, which the author supposes to depend on this resinous substance.

Of 180 species of *myrsineae* 58 are described for the first time by the author. They grow commonly on the hilly and mountainous regions of the hottest parts of the globe. None have yet been found beyond the 39th or 40th degree of latitude, viz. in Japan, whilst they abound in Java and in some parts of India and South America. No species is known in Africa except at the Cape and at the Canary Islands, Mauritius, Bourbon and Madagascar. The 180 species are distributed as follows: 112 in Asia and New Holland, 48 in America, and 20 in Africa.

Mr Don, in his paper, shews that the form of aestivation of the corolla is of great importance as a character to distinguish different families, especially among the monopetalous orders, except in the order *Rubiaceae,* where examples of every kind of modification occur. In the Cinchona *grandiflora and rosea* it is imbricate, in *C lanceolata* and the rest of the true cinchonae it is valvate, while in the West Indian species it is induplicate and in the *C exelsa* plaited. Of the genus cinchona he enumerates seventeen true species. 2. Combuena, (C grandiflora) two species; *obtusifolia* and *acuminati*; 3. Lasionema (C rosea) *roseum*; 4. Exostema, seven species; 5. Hymenodictyon (C excelsa) *exelsum and thyrsiflorum*; 6. Luculia *gratissima* and *cuneifolia*; 7. Pinckneya *pubens.*

The other paper of Mr. Don is upon the Tropaeolum pentaphyllum of Lamarck, which has been introduced into this country by Mr. Neill of Edinburgh. He shews that it differs from the genus Tropaeolum in having the aestivation of its calyx valvate, that of Tropaeolum being imbricate. In the nature of its fruit, which is a black juicy berry resembling the Zante grape, and in the reduced number of its petals. He has formed it into a new genus, and terms it Chymocarpus *pentaphyllus.* Its calyx is persistent, while that of Tropaeolum is deciduous. The embryo is small and white, contained in a thin cartilaginous testa, and the cotyledons round and compressed. It belongs to the natural order Tropaeoleae, and is a native of the sandy plains of Buenos Ayres. It was first observed by Commerson, and afterwards by Tweedie.

Mr. Royle has endeavoured to identify the plant termed *Lycium* by Dioscorides. The *lycium* of Asia Minor he considers may be made from the Rhamnus *infectorius*, or different species of Rhamnus, or the Berberis *vulgaris*. The *lycium* of India, again, he identifies with the produce of the Berberis *aristata*, occurring on Choor mountain, 5000 to 8000 feet high, called in *Arabic*, Amburbarees, in Persian Zirishk, the *Wood* darkhuld and darchob, the *extract* hooziz, the hill name being chitrach, and also with the extract obtained from the B *lycium* growing at Mussooree, 3000 to 5000 feet of elevation, called *Kushmul*, the extract *rusot*.

This *rusot* can be procured in every bazar in India, and is used by the native practitioners in chronic and acute inflammations of the eye, both simply and combined with alum and opium. It was employed by Mr. M'Dowell in the Egyptian ophthalmia, and Mr. Royle has applied it with beneficial effects in cases succeeding acute inflammation. The extract is rubbed to a proper consistence with a little water, sometimes with opium and alum and is then applied in a thick layer over the swollen eyelids. The addition of a little oil renders the preparation less desiccative.

It is mentioned in the *Mukhzun-ool-udwieh*, (store house for medicines) under the name of *loofyon*, which is obviously the same as *lookyon* of the Greeks. Dioscorides describes it as being formed from a shrub called *Lonchitis*, which is thorny, and has branches three or more cubits in length, whose bark, when bruised, becomes of a reddish colour and whose leaves resemble those of the olive. In these respects Mr. Royle's plant agrees with that of Dioscorides. Indeed we have rarely seen a more plausible deduction from etymology than is exhibited in the present instance. It is to be regretted, however, that the *rusot* has not yet found its way into chemical hands.

Comparative Anatomy, &c.

Mr. Yarrell describes the organs of voice in the Cygnus *buccinatur*, a new species of swan, figured by Dr. Richardson, from the interior of the fur countries of North America. This species, which is called the Trumpeter, furnishes the largest portion of the supply of swan skins imported by the Hudson's Bay Company. Its beak is black; its trachea is made up of narrow bony rings and small intervening membranous spaces as far as the first convolution within the sternum; but the returning portion of the tube, forming a second convolution, is composed of broader and stronger bony rings, with wider intervals. The course of the trachea within the sternum differs from that of the hooper, for after descending by the neck it passes backwards within the keel, and between the two plates of the back bone to the depth of six inches, then curving horizontally and slightly inclining upwards, returns at first by the side of and afterwards over the first inserted portion near two thirds of the whole distance. A second curve of this returning portion is then suddenly elevated two inches above the line of the superior surface of the keel, and traverses the interior of a hollow circular protuberance on the dorsal surface of the sternum itself. The usual ascending curve of the trachea then takes place, by which the tube, ultimately receding, gains the interior cavity of the breast. The bronchiae are two inches long. Such are the peculiarities which characterize this new species.

Two species of *Leuciscus*, or dace family of fish, are described by Mr. Yarrell, one of which, *L. Lancastriensis*, was merely noticed by Mr. Pennant as likely to be new under the name of Graining. It is more slender than the dace. In the latter the length is to the depth as 4 to 1, but in the graining as 5 to 1. The head and back are of a pale drab colour, tinged with red; irides, yellowish-white; the fins pale yellowish-white. In the dace the back and sides yellowish olive-coloured, tinged with blue; lower fins pale red, with a smaller number of fin rays in some fins, in others less. It occurs in a stream which rises in Knowsly Park, in the Mersey and in the Alt. L. elongatus, pinna dorsali supra pinnas ventrales posita, caudali profunde biloba, capitis lateribus supra subparallelis ore parvo, dorso lateribusque superne subrufescenti, isabellinis inferne ventreque argenteis.

The other species, L *cœruleus* is quite new. He gives it the English name of Azurine. Its depth is to its length as 7 to 2, resembling the *red eye* in shape, but is easily distinguished from that species by the silvery whiteness of the abdomen, which in the *red eye* is of a brilliant golden orange, and also by its white fins, which in the other are vermilion. L ovato-lanceolatus, pinna dorsali pone pinnas ventrales posita, dorso plumbeo, ventre argenteo, pinnis albis.

B 3 D 10 P 16 V 9 A 12 C 19.

Mr. Guilding observes that the *Naticidae* form a very distinct family from the *Neritidae*. The former are apparently blind, the operculum has no appendages; their useless tentacula are weak and turned back on the shell, while in the act of creeping the head and its organs are perfectly veiled by a broad expanded hood, the sensible contractile apex of which serves to guide its motions. At first sight they rather resemble the *Bullidae*.

He describes and figures two species of Dentalium, viz. D *Semistriolatum*, and D *Sowerbyi*. Very little is known with regard to this genus. M. Deshayes had previously thrown some light on its history, but its position in the natural system is not yet made out. Mr. Guilding is inclined to place it near *patellae*. It resembles in its vent the genus *fissurella*, in its apical fissure the posterior marginal rima of *emarginula*.

Dr. Buckland, in that spirit of benevolence with which the writings of naturalists are almost universally inspired, reproves the harsh sentence which has been passed on the sloth by Cuvier and strives to show that this vulgar type of indolence is undeserving the imputation of feebleness or imperfection, and still more of the charge of monstrosity; that it affords a striking example of perfect mechanism and contrivance when viewed in reference to the office it is destined to fulfil, " the animal being fitted to its state."

Cuvier has stated that we find in sloths such few relations to ordinary animals that the general laws of existing organizations supply so little to them, and the different parts of their body seem so much at varience with the laws of co-existence which we find established throughout the rest of the animal kingdom, that we might really believe them to be the remains of another order of things, the living relics of that preceding state of nature whose ruins we are obliged to search for in the interior of the earth, and that they have by some miracle escaped the catastrophe which destroyed the other species which were their contemporaries. The skeleton of the *Bradypus tridactylus*, or *Ai*, says Cuvier, affords proportions extremely anomalous, and apparently defective; the arms and fore-arms taken together are almost double the length of the thigh and leg, so that when the animal goes on all fours he is obliged to drag himself upon his elbows, and if he attempted to stand erect upon his hind feet the entire fore foot would still rest upon the ground; but the *Ai* never can stand upright, because his hind feet are so ill articulated for walking that they are unable to support the body in such a position; the pelvis is also so broad, and its cotaloid cavities so set back that the thighs are kept at a distance, strutting outwards, and the knees can never approach one another. The length of the fore legs embarrasses the animal in its attempts to walk, and its forward movements on the ground are made by fixing its claws on an object and then dragging its body up to it. This is the unfavourable side of the subject. Dr. Buckland views it in a benevolent light. The extraordinary length of the arm, and fore arm, so inconvenient for moving on the earth, are of essential and obvious utility to a creature whose body is of too great weight to allow it to crawl to the extremity of the branches to collect the extreme buds and youngest leaves which form its food; these long arms, in fact, perform the office of the instrument called "lazy tongs," whereby the creature brings food to the mouth from a distant point without any movement of the trunk. The structure of the arm fixed to the shoulder by an universal joint admitting of rotation, and having at the elbow two kinds of articulations which allow pronation and supination, gives to the hand a power of moving in every possible direction. The breadth of the pelvis and outward position of the thigh bones, which are also broad and flat, the distance of the knees from one another, and curvature of the bones of the leg, admirably adapt these extremities of the animal to the purpose of clasping, and, as it were, riding upon the trunks and branches of trees: A peculiar condition of life was to be provided for, viz. that of a quadruped which was to feed, to sleep, and in short, to dwell entirely upon trees, for the succulent nature of its food renders it necessary to descend to drink; and if we look at the anomalous extremities of this animal with a view to their use as instruments of continual suspension upon trunks and branches, the hind legs performing the double office of adhesion and progression, and the fore legs the quadruple function of adhesion, progression, prehension and defence, we shall find each article of deviation from ordinary structure adapted to some useful function in its peculiar economy, we shall find a new system of machinery contrived and set together as it were on a new plan, from old materials, (as machines of different functions may be compounded from similar wheels, every motion having relation to some well defined and useful end) and the result of these deviations presenting an animal structure not less perfect, in reference to its state, than those slender and graceful forms of light and active quadrupeds with which we usually, and perhaps more justly, associate our ideas of perfect symmetry and beauty.

The stiffness of the toes and fingers of this animal, which fit it for the habit of constantly living and feeding upon trees; and the difficulty of motion in other joints become advantageous and a source of strength to an animal living as it does, while to one moving on the ground, they would be a source of great inconvenience. The claws of the Sloth are of unusual length, and so powerful that they are capable of strangling a dog, holding him at arm's length. On trees the Sloth is surprisingly tenacious of its hold. Mr. Burchell has seen the limbs, even just after death, continue fast clinging round the object to which they were adhering before the animal expired. All mammalia, from the Giraffe and Camel down to the Cetacea, have invariably seven cervical vertetræ, while the Sloth was considered to have nine. Mr. T. Bell has, however, shewn that the two lowest are really dorsal, but their position so far in advance of the clavicle and scapula, enables them to co-operate with the seven true cervical vertebræ, in increasing the rotatory motion and flexibility of the neck. Hence, the animal has the power of looking backward over its own shoulder. Mr. Burchell has observed, that this animal can turn its head quite round, and stare a person in the face who is directly in its rear, while at the same time the body and limbs are unmoved. He also noticed, that his captive Sloths assumed during sleep, a position of perfect ease and safety on the fork of a tree; their arms embracing the trunk, their backs resting in the angle of a branch, and their heads reclining on their own bosom, the animal being thus rolled up nearly in the form of a ball, with the vertebral column bent circular. The Sloth has no incisor teeth, because the leaves are brought to the mouth, being collected from the branches by the powerful claws.

Besides the four canine teeth, there are on each side four molars in the upper and three in the lower jaw. The construction of these teeth is the most simple that exists; they are composed of a cylinder of bone encased with enamel and hollow at the two extremities, the upper cavity being produced by the act of mastication, which wears away the softer bony texture of the interior more readily than the exterior enamel, and the lower cavity being filled with gelatinous pulp which maintains the continual growth of the tooth, these simple teeth being employed exclusively in the mastication of buds and leaves are fully adequate to the wants of an animal which has no need of more complicated teeth. Mr. Waterton states, that he "in crossing the Esquibo one day, saw a large two-toed sloth on the ground upon the bank, though the trees were not twenty yards from him, he could not make his way through the sand time enough to make his escape before we landed, he threw himself on his back and defended himself with his fore legs. I took a long stick and held it for him to hook on, and then conveyed him to a high and stately mora, he ascended with wonderful rapidity, and in about a minute he was almost at the top of the tree; he now went off in a side direction and caught hold of the branch of a neighbouring tree, he then proceeded towards the heart of the forest."

When resident at Para, near the mouth of the Amazons, Mr. Burchell kept two full grown Sloths and a young one of a three-toed species, in a garden enclosed with strong stockades; they were kept tied up to the pillars of a verandah to prevent their escape; against these pillars they always placed themselves in an erect position, embracing the pillar with all four legs; when not tied to the verandah they got up into trees in the garden; they slept both day and night, always fixing their arms round something or other; their food consisting of branches was brought to them in the verandah; they appeared extremely stupid, and would never come to the food; they would eat no leaves but those of the *Cecropia.*

None of these animals were ever seen to drink. The full-grown ones were never heard to utter any sound, but the young one occasionally (though rarely) gave a short cry or whistling squeak of a single note. They shewed no indication of fear and seemed to give attention only with their eyes. They took no notice of the boy that carried them often across the garden to their place in the verandah with their long arms sprawling—the only objects of their regard were trees —they fight on their backs and grapple their enemy to strangulation. The use of the long wool that covers the body and even the face, seems to guard them from the annoyance of insects.

Much as we admire the feeling which has dictated the criticism of Dr. Buckland, we cannot help remarking, that the observations which he has collected, although they tend to shew that the animal is fitted to its state, confirm the suspicion that that state is a wretched one, and bears few relations to that of ordinary animals.

II.—*Facts, Laws, and Phenomena of Natural Philosophy, &c.* Translated from the French of Professor Quetelet of Brussels. With Notes by Robert Wallace. Glasgow, 1835, 12mo.

For this translation we are indebted to the industry of some young ladies in the vicinity of Glasgow. Mr. Wallace the editor states, that having been called to give lessons to some young ladies who were desirous of acquiring a knowledge of Natural Philosophy, he proposed that they should employ M. Quetelet's work as a text-book. This proposal was adopted, the work translated, and the result of their labours is now presented to the public. It is extremely gratifying to see the tender sex not only enriching our books of science with their pencils, but actually studying something more than mere superficialities.

M. Quetelet is concise in his statement of facts, of which the work forms a good digest. The translation appears well executed, with the exception, that the English proper names are in general not translated. The recent important discoveries in electricity by Dr. Faraday have entirely escaped the notice of the author, but should have been introduced by the editor, as they include some very curious phenomena and constitute a very essential part of the science. This, of course, will be attended to in another edition, which from the value of the publication, as an elementary book, may be required.

III.—*Procceedings of the Berwickshire Naturalists' Club*, p. 64.

THE Club whose proceedings are now before us was instituted in 1831, for the purpose of examining the natural history and antiquities of the county and its vicinity. The members meet in different parts of the district, five times within the year, and after making an excursion in the neighbourhood of the place of meeting, accounts are given of the discoveries which have been made in the different branches of science, during the interval, from the preceding meeting. The object of this association has been well described by Dr. Johnston, its first president, and the author of the Flora of Berwick. "It affords," says he, "a point of rendezvous for the naturalists of the district, where they may cultivate a mutual acquaintance; where they may talk over their common pursuits and all its incidents; where they may mutually give and receive oral information; where each may nourish his neighbour's zeal; where we may have our 'careless season' and enjoy 'perfect gladsomeness.'"

That its establishment has not been in vain, is proved by the facts, that several new zoophytes have been discovered by Dr. Johnston, viz. *Plumularia Catharina, Fleminea muricata*, &c. While a new plant the *Tragopogon major* has been added to the British flora, and new habitats detected of some of the rarest plants, by members of the club.

The first number of the transactions contains the addresses of the two presidents, Dr. Johnston and Mr. Baird on retiring from the chair, in which they give a succinct account of the proceedings of the association. In Dr. Johnston's address, a fact is mentioned in reference to plants, similar to what has been subsequently noticed by Dr. Johnson of Shrewsbury. The former gentleman says, "During our excursion to Cheviot, it was accidently observed that where specimens of the butterwort *(Pinguicula vulgaris)* were somewhat rudely pulled up, the flower stalk previously erect, almost immediately began to bend itself backwards, and formed a more or less perfect segment of a circle, and so also if a specimen is placed in the botanic box, you will in a short time find that the leaves have curled themselves backwards, and now conceal the root by their revolution. Now, the butterwort is a very common plant, yet I am not aware, that this fact of its irritability has ever been mentioned."

This fact, * and those which Dr. Johnson has brought forward are interesting, but can only be considered as an extension of our knowledge of that principle of irritability which is so remarkable in many plants.

The second number begins with the address of Mr. Selby, the author of Illustrations of British Ornithology, in which the proceedings of the club during 1834 are detailed. The same gentleman mentions that he had succeeded in capturing the *Macroglossa stellatarum* or humming bird moth, one of our rarest insects, in his garden at Twizell House.

In a notice of facts relating to the *Tormentilla officinalis*, by the editor of this journal, it is stated, that of 3700 specimens of flowers examined by him, 3628 had all the characters of Tormentilla, 43 possessed those of Potentilla, while the remaining 29 varied in the number and proportion of the divisions of the calyx and corolla. From which it would appear, that the genus Tormentilla, as was maintained by the accurate Sir James Smith, does exist, and that the occasional multiplicity of petals and sepals is to be referred to luxuriance of growth.

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* Phil. Mag. vi. 164.

Mr. W. Baird in a notice of the aurora borealis mentions, that on one occasion, when this phenomenon was remarkably vivid, he thought he heard a momentary sound resembling the noise produced by the quick flight of a bird over head.

Dr. Johnston describes and figures three Roman urns of coarse clay, which were dug up near Berwick. He considers them to possess all the interest attached to antiquities of 1400 years existence.

This number terminates with a list of additions to the Flora of Berwick, which have been made since the publication of Dr. Johnston's Flora.

We would heartily recommend to naturalists in provincial parts of the country, the establishment of societies like the club of Berwickshire, because we are convinced, that they will tend to nourish that scientific spirit, which for want of due encouragement is too often blasted in the bud.

IV.—*Abstract of a Paper on the Refraction and Polarization of Heat.* By PROFESSOR FORBES. (Read before the Royal Society of Edinburgh on 29th January 1835.)

THE First Section of this paper contains an account of a variety of experiments undertaken with the thermo-multiplier of Nobili and Melloni, the instrument exclusively employed in the subsequent researches. By a comparison of its sensibility with that of air thermometers, the author concludes that one degree of deviation of the needle of the multiplier corresponds to an effect indicated by about one-fiftieth of a centigrade degree on the others. Without increasing the dimensions of the multiplier, by which its sensibility would be impaired, he has been enabled, by an optical contrivance, readily to measure one-tenth of one of its degrees, corresponding to one-five hundredth of a centigrade degree. From an experiment intended to detect the heat of the lunar rays, concentrated by a polyzonal lens, thirty-two inches in diameter, and acting upon this instrument, he concludes that the direct effect of the moon upon an air-thermometer probably does not amount to *one-three hundredth thousandth* part of a centigrade degree.

After mentioning his repetition of M. Melloni's experiments upon the refraction of heat, the author proceeds, in the Second Section, to give an account of his own researches on the action of tourmaline on heat. At first he found (as it afterwards appeared M. Melloni had done) that no more heat was stopped when the tourmaline plates had their axes crossed, or transmitted least light, than when they were parallel, or transmitted most. He afterwards detected a fallacy in his mode of operation, and proved the polarization of heat, whether luminous or obscure, by tourmaline.

The Third Section treats of the polarization of heat by refraction and reflection. The former method the author found by far the most convenient, employing thin plates of mica, arranged at the polarizing angle, and through which even dark heat was very freely transmitted. The results were so marked that they were verified in a great variety of ways, and with heat from sources extremely different, as that of an argand lamp, and water below 200° Fahr. The polarization of non-luminous heat by *reflection* was also established, though with much less ease and simplicity. In this form it was announced by Berard about twenty years ago, but hitherto his experiment does not appear to have been repeated with success.

The Fourth Section considers the modifications which polarized heat undergoes by the action of doubly refracting crystals. The analogies here are derived entirely from those of light. Very numerous experiments are quoted to shew that the effects are quite analogous, even when the source of heat is water under the boiling point. The doubly refracting substance used to depolarize was generally mica. Out of 157 recorded experiments on depolarization, with three different mica plates, only one gave a neutral and one a negative result. Yet of these 157 experiments, no less than 92 were made with heat unaccompanied by any visible light. One very striking experiment is quoted in illustration of the marked nature of the effects. When the polarizing and analyzing plates were situated so as to transmit least heat to the pile, and a thin film of mica was interposed between the plates in such a position as would depolarize light under similar circumstances, the film was found to *stop* more heat than it *depolarized*, or the needle moved towards zero; but if a mica film much *thicker* (so much thicker as to stop *more than twice* as much common heat as the first) was similarly placed, that film *depolarized* more than it *stopped*, and the needle moved in the opposite direction to the former one. The investigation of the laws of depolarization given in this section are hardly capable of abridgment..

The following are the general conclusions:—*

1. Heat, whether luminous or obscure, is capable of Polarization by Tourmaline.

2. It may be polarized by Refraction.

3. It may be polarized by Reflection.

4. It may be depolarized by Doubly Refracting Crystals. Hence—

5. It is capable of double refraction and the two rays are polarized. When suitably modified, these rays are capable of interfering like those of light.

6. The characteristic law of polarization in the case of light holds in that of heat; viz., that the intensities in rectangular positions of the polarizing and analyzing plates are complementary to each other.

7. As a necessary consequence of the above, confirmed by experiment, heat is susceptible of circular and elliptic polarization.

8. The undulations of obscure heat are probably longer than those of light. A method is pointed out of deducing their length numerically.

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* These conclusions were stated nearly in these words (except the 6th) to the Royal Society on the 5th January.

Article IX.

SCIENTIFIC INTELLIGENCE.

Royal Institution—27th February.

I.—*Floor Cloth Manufactory.*—Mr. Brande gave a description of this manufacture, and added greatly to its interest by going through the various steps of the process, with the assistance of some workmen employed in the manufactory at Knightsbridge. The main part of the manipulation is similar to calico-printing, the figures on the blocks being upon a much larger scale, and the cloths which are printed being of an infinitely greater size. The common dimensions of a floor cloth are 210 or 220 square yards, and hence the immense size and often unseemly appearance of floor cloth works. A stout canvass is chosen in the first instance. This is nailed to one extremity of a wooden frame, and stretched by means of hooks which are attached to the other sides. It is then washed with a weak size and rubbed over with pumice stone. No other substance has yet been found which answers the purpose so well as this mineral. The next step is that of laying on the colour, which is performed by placing dabs of paint over the canvass with a brush, and then rubbing or polishing it with a long peculiar shaped trowel. Four coats of paint are thus applied in front and three on the back of the cloth. To remove it from the frame when these processes are finished, a roller on a carriage is employed, upon which it is rolled and conveyed to the extremity of the manufactory for the purpose of being printed.

It is then gradually transferred from the roller and passed over a table which is 30 feet long and 4 feet wide, made of planks placed vertically, and as it proceeds over the table, the blocks, dipped in the appropriate colours, are applied. The colours used are ochre, umber, vermilion, and different kinds of chrome, mixed up with lintseed oil and a little turpentine.

The number of blocks applied to one pattern depends upon the number of colours.

The first mode of applying the patterns was by stencils, that is, the pattern was cut out in paper, and when the paper thus prepared was applied to the cloth to be painted, that portion where the ground was exposed by the interstice in the paper was traversed by a brush. Then a combination of stencilling and printing was had recourse to, the former process being first made use of, and then a block was applied, the stencilling forming the groundwork. Stencilling is now abandoned. In printing, it is necessary that the cloth should first be rubbed over with a brush, else the colours will not adhere. Whether the effect is electrical or not has not been ascertained. Every square yard of good oil cloth weighs 3½ or 4½ lbs. each gaining by the application of the paint 3 or 4 lbs. weight, and hence, the quality of this manufacture is judged of by the weight. Whiting is often used in spurious cloths, mixed with oil. Cloth prepared in this way speedily cracks and becomes useless.

Good cloth, with a very stout canvass, is used for covering verandahs, and will last nine or ten years, while spurious cloth will become useless in the course of one year. Floor cloth is employed to cover roofs, as at the manufactory at Knightsbridge, and for gutters. In the latter case it is remarkable that water remaining in contact with it produces no injurious effect.

Painted baize for tables is usually manufactured with a smooth side, and is printed with blocks of a fine structure, resembling calico blocks. Fine canvass is employed; several coats of paint are laid on upon one side, and the other receives one coat, and is then strewed over with wool, or flocked, as it is called.

II.—*Present State of Jerusalem. 13th March.*—The object of the lecture delivered by Mr. Davidson was to prove that the present site of the walls of Jerusalem is the same as that of ancient times. Dr. Clarke has argued that the Holy Sepulchre must have been in the present Valley of Hinnom, because we are told that it was outside the city, and that it was hewn out of a rock. The lecturer endeavoured to shew, however, that the spot at present pointed out as the scene of death was actually without the city until the time of Adrian, who inclosed this portion of the suburbs by a wall, and that the original may not signify rock but stone. This common acceptation, however, may be adopted, because the foundations of the houses at present in this quarter of the city are seated on compact limestone. The lecturer described particularly the present desolate appearance of the city, (about three miles in circumference) and the great feeling of disappointment which he experienced on first obtaining a sight of it, a prospect which can scarcely whisper what it has been. In reference to the great amount of population of which we read in Scripture, compared with the extent of surface occupied by the city, Mr. Davidson observed that the only account we have of the number of the inhabitants was upon the great occasion of the feast; for the storming of the city by the Romans took place at that period. He described the Mosque of Omar, which occupies the place of Solomon's Temple This is the great resort of the Mussulman pilgrims, and, although a fine building, is insignificant when compared with the great Jewish Temple, which it is calculated cost above 830 millions of pounds Sterling. A model of the mosque was exhibited, and the speedy appearance announced of a splendid panoramic view of the modern Jerusalem, by Mr. Catherwood, taken from the top of one of the houses within the city.

III.—*Manufacture of Pens. By Dr. Faraday. 27th March.* Quills appear to have been employed, at least, as early as the seventh century. England is supplied with this article from Russia and Poland, where immense flocks of geese are fed for the sake of their quills. The quantity exported from St. Petersburg, varies from six to twenty-seven millions. Twenty millions were last year imported into England from these countries. We may form some idea of the number of geese which must be required to afford the supply, when we consider, that each wing produces about five good quills and that by proper management, a goose may afford twenty quills during the year. Hence, it is obvious, that the geese of Great Britain and Ireland, could afford but a very limited supply. The feathers of the geese of the latter countries are employed for making beds.

The preparation of quills, or *touching* as it is called, is a curious and nice process. The Dutch possessed the complete monopoly of the quill manufacture until about 70 years ago, when the process was introduced into this country, and now our quills are infinitely superior to those of Holland.

The quills are first moistened, not by immersion, but by dipping their extremities into water and allowing the remaining parts to absorb moisture by capillary attraction. They are then heated in the fire or in a charcoal choffer, and are passed quickly under an instrument with a fine edge which flattens them, in such a manner as to render them apparently useless. They are then scraped, and again exposed to heat, when they are restored to their original form. This is a remarkable fact, and deserves to be attended to. It may be illustrated by taking a feather and crushing it with the hand, so as to destroy it to all appearance. If we now expose it to the action of steam or a similar temperature, it will speedily assume its pristine condition.

Many of the quills after this preparation are cut into pens by means of the pen cutters knife, and are also trimmed. A pen cutter will cut in a day, two-thirds of a long thousand, which consists of 1200 according to the Stationers' computation. A house in Shoe Lane, cuts generally about six millions of pens, and last year, notwithstanding the introduction of steel pens, it cut many more than it had done in any previous years. According to the calculations of the pen makers not more than one pen in ten is ever mended.

About thirty-one years ago, Mr. Bramah introduced portable pens into this country from New York, and took out a patent for their manufacture. The process for making portable pens is to form a vertical section of the barrel of the quill and polish the pieces. The pens are then cut with a beautiful instrument, each quill affording six pens. When they have been nipped coarsely, a polish is given with the pen-knife. Sixty thousand of these pens are manufactured weekly by two houses. An attempt was made to apply steel tips to portable quill pens, but the success which was anticipated did not follow.

Metallic pens appear to have been first introduced as rewards for merit, but steel pens for writing were first made by Mr. Wise, in 1803, and were fashioned like goose pens.

A patent was taken out in 1812, for pens with flat cheeks, and in this way all metallic pens were made for some time, as the rhodium pen of Dr. Wollaston, and the iridium pen of others. About twelve years ago, Mr. Perry began to make pens, and about six years ago they began to be manufactured at Birmingham. The steel is pressed into thin sheets by a rolling press. It is then cut into slips, annealed for fourteen hours, and again passed under the roller. By means of a peculiar cutting machine the pens are formed in a falchion shape. But one half of the steel is thus wasted, and no use has been found for it. It is so thin that it cannot be welded, and it cannot be melted because it catches fire, and burns in consequence of the air getting access between its thin leaves. The fibres of the steel run in one direction, and the pens are cut in accordance with this disposition. The pens are then annealed. The preparation for forming the slit then takes place. An extremely fine edged chisel is brought down upon each separately, and is allowed to penetrate $\frac{2}{3}$ through its substance. The edge of this instrument is finer than any razor, but is much harder, as it does not require to receive an edge during the whole of the day. This superior quality is given to the steel by beating it for several hours with a hammer. It is an important fact, and appears to have been discovered by the pen manufacturers. A triangular piece is next cut out at the upper end of the slit in the pen, which is called *piercing*. The next object is to give them their proper shape, which is effected by means of a punch fitting into a corresponding concavity.

The pens are then heated red hot and dipped into oil, which must be at least 3 feet deep. The oil in a few weeks looses its properties and becomes charred. The next operation is polishing. This is effected in a peculiar apparatus, called emphatically the *devil*, con-consisting of a fly wheel and box in which the pens are placed, and to which a motion is given, resembling that required in shaking together materials in a bag. This motion is continued for eight hours, when the pens are found to be completely deprived by the friction against each other of any asperities which might have existed on their edges, and though not visible to the naked eye, would have obstructed the free motion of the pen in writing. After this they are tempered in a box, shaken and brought to a blue colour, being carefully watched, and the heat lessened whenever a shade of yellow is observed on their surface. The split is now completed by touching its side with a pair of pincers.

With regard to the number of steel pens made, from information communicated to Dr. Faraday, it appears that Mr. Perry manufactures one hundred thousand weekly, or five million two hundred thousand per annum. Mr. Gillot employs 300 pair of hands, and consumes 40 tons of steel annually. Now, 1 ton of steel produces about two millions of pens. Hence, this manufacturer alone makes eighty millions of pens annually. The total quantity of steel employed in this country for making pens amounts to 120 tons, which is equivalent to about two hundred millions of pens.

Notwithstanding the immense product of the manufacture, it is remarkable that the consumption of quills has not diminished, indeed, it is on the increase; this may be accounted for by the consideration that within the last 10 or 15 years, the population has increased $\frac{1}{3}$, and 3 people now can write for 1 at the commencement of that period; and besides, both the Continent and America are supplied by us. When first introduced, steel pens were as high as 8s. per gross, then they fell to 4s. and recently have been manufactured at Birmingham at as low a price as 4d. the gross. It appears that the only interest that has suffered by the employment of steel pens, is that of the pen-knife makers. Pens have also been made of horn and tortoise-shell, and it is no small consolation to consider that if steel should fail us we can have recourse to such abundant materials.

Scientific Books in the Press and on hand.

MARTINET'S MANUAL OF PATHOLOGY: Edited by JONES QUAIN, M.D. Professor of Anatomy and Physiology in the University of London. A New Edition, with numerous Additions.

NATURAL HISTORY of the ORDER CETACEA and the OCEANIC Inhabitants of the Arctic Regions. By H. W. DEWHURST, SURGEON.

Meteorological Journal,

Kept at the Manse of the Parish of Abbey St. Bathan's, Berwickshire, Lat. 55° 52′ N. Long. 2° 23′ W. at the height of about 450 feet above the sea. By the Rev. John Wallace.

MARCH.

DATE.			THERMOMETER.				HYGROMETER (Leslie's.)				BAROMETER. At 32° of Fahrenheit.				Rain in Inches. Weekly.	Prevailing Winds.	REMARKS.
1835.			IX. A.M. °	X. A.M. °	III. P.M. °	X. P.M. °	IX. AM °	X. AM °	III. PM °	X. PM °	IX. A.M.	X. A.M.	III P.M.	X. P.M.			
	Su.	1	34½	38	41	24	5	4	15	,,	29·036	29·069	29·266	29·537	1·078	N. Ey.	A.M. heavy clouds, P.M partially clear, evening clear with intense frost.
	Mo.	2	36½	41¼	44	41¾	*	,,	,,	,,	29·159	29·107	29·084	29·790		S. Wy.	Strong gale with flying showers.
	Tu.	3	35½	37¾	40	34	,,	,,	,,	,,	28·731	28·726	28·943	29·172		N. Wy.	Strong gale with flying snow showers.
	We.	4	37¾	38	40½	32¼	,,	,,	,,	,,	29·055	29·016	28·907	29·041		Wy.	Brisk gale, prevailing clouds the cirrus and cirrostratus formations.
	Th.	5	35½	38	39½	37	,,	,,	,,	,,	29·306	29·298	29·165	28·586		S. Wy.	Brisk gale, 10 P.M. calm with rain, wind again rising with sudden gusts.
	Fr.	6	40½	41	39	32½	,,	,,	,,	,,	28·561	28·631	28·907	28·885		N. Wy.	Occasionally clear, but boisterous and showery, evening calm, lunar halo.
	Sa.	7	33	35	35½	33	,,	,,	,,	,,	28·357	28·363	28·555	28·940		N. Ey.	Snow, with tendency to thaw, P.M. strong gale.
	Su.	8	30	33	36	30¾	9	10½	15	7	29·195	29·201	29·166	28·932	0·939	N. Ey.	Fine, calm, clear, evening sky overspread with a thin hazy cloud, wind rising.
	Mo.	9	36	40¼	41	34¼	7	7	12	9	28·618	28·622	28·524	28·428		Ny.	Calm, overcast, 10 P.M. brisk gale rising.
	Tu.	10	34¾	37¼	38½	34½	12	12	18	12	28·652	28·695	28·890	28·841		Wy.	Calm, A.M. cloudy, P.M. clear, evening overcast, lunar halo.
	We.	11	41¾	42¾	38	35	9	12	7	7	28·684	28·704	28·787	28·905		S. Wy.	Calm, interrupted by occasional gusts, 3 P.M. snow and hail showers, occasionally clear.
	Th.	12	39	40¼	44	36¾	7½	10½	19	12	28·996	29·033	29·119	29·317		S. Wy.	Gentle breeze, thin white clouds, faint lunar halo.
	Fr.	13	40½	42	45¾	40	10	15	20	17	29·531	29·549	29·557	29·399		S. Wy.	Calm, fine, sky nearly veiled with various kinds of cirrostratus.
Full M.	Sa.	14	48	49	46	37	9	15	20	3½	29·157	29·157	29·232	29·320		S. Wy.	Brisk gale interrupted by occasional calms, evening clear and calm.
	Su.	15	41¼	43	44½	37½	8	12	18	7	29·274	29·275	29·289	29·288	0·547	Wy.	Brisk gale, cumuli, evening the sky overspread with a thin veil of cloud.
	Mo.	16	45¼	47¼	48½	37½	12½	12½	27	7	29·373	29·395	29·418	29·427		N. Wy.	Fine gentle breeze, cumuli, evening thin cloud.
	Tu.	17	43½	43	42	39½	5	5	4	0	29·246	29·238	29·231	29·387		Wy.	Calm, with continued but not heavy rain since 8 A.M.
	We.	18	41¾	44½	46½	33½	3	9	11	0	29·636	29·645	29·658	29·639		Ny.	Calm, cloudy, evening haze.
	Th.	19	44½	44½	47½	41¾	6½	9½	9	4½	29·598	29·568	29·569	29·620		S. Wy.	Brisk wind, cloudy (cirrostratus) evening partially clear.
	Fr.	20	51	53½	56	47½	7½	11	23	5	29·640	29·654	29·665	29·708		S. Wy.	Gentle breeze, A.M. soft clouds, noon partially clear, evening calm and cloudy.
	Sa.	21	53½	53¼	51¾	39½	6½	16	8	5	29·672	29·660	29·726	29·843		N. Ey.	A.M. fine, cirrostratus of various kinds P.M. overcast, evening calm but hazy.
	Su.	22	44	44½	44½	39	3	7	9	0	29·925	29·932	29·935	29·986	0.016	N. Ey.	Hoar frost, hazy with large masses of cumuli, calm, evening overcast.
	Mo.	23	47	46	43¼	38	5½	9	8½	0	29·994	29·994	29·977	30·016		N. Ey.	Deposition, calm, occasionally partially clear, with masses of cumuli, evening overcast.
	Tu.	24	43¾	44	44¼	30	10	12	16	0	30·064	30·074	30·074	30·118		N. Ey.	Calm, cloudy, evening clear and frosty.
	We.	25	42¾	46½	50	37½	11	18	26	7	30·077	30·117	30·077	30·032		N. Wy.	Hoar frost, calm, cloudless, with light haziness, at 6 P.M sky cirrostratus.
	Th.	26	47	48	53¾	45	13	19	26	10	29·893	29·887	29·827	29·896		N. of W.	Brisk gale, nearly cloudless, evening calm and cloudy, at 10 P.M. overcast.
	Fr.	27	44½	47	53	31½	11½	13	14	0	29·929	29·933	29·900	29·889		N. Ey.	Calm, cloudy, but occasionally clear.
	Sa.	28	43¾	44¼	39½	36½	12	10	6	6	29·799	29·797	29·747	29·735		N. Ey.	Hoar frost, cloudy and lowering, P.M. rain, evening calm but overcast.
NewM.	Su.	29	44	45¼	43	35½	11	12	13	5	29·626	29·616	29·513	29·417	0·063	Sy.	Calm, cloudy, for the most part overcast.
	Mo.	30	45½	45½	47¾	40½	10	20	23½	3	29·218	29·219	29·115	29·118		S. Wy.	A.M. sky overspread with white fleecy clouds P.M. brisk wind, even. cloudy.
	Tu.	31	45½	48¼	47½	45½	0	6	2	0	29·120	29·117	29·045	29·053		Sy.	A.M. overcast with tendency to rain, rain, wind Ey. evening fair, but overcast.
Means.			41·7	43·3	44·3	36·8	8·1	11·5	14·8	5·3	29·327	29·332	29·351	29·396	2·643		Means for the Month } Therm. 41·½° Hygr. 9·92 Bar. 29·351. Mean temperature of spring water 41⅜° Mean point of deposition 34·2° Moisture in a cubic inch of air ·00147.

RECORDS

OF

GENERAL SCIENCE.

JUNE, 1835.

ARTICLE I.

Biographical Notice of M. Chaptal. (*Ann. de Chim.* lii. 205.)

JEAN ANTOINE CHAPTAL was born at Nozaret (Lozere) in 1756. He was educated at Mende, from whence he repaired to the School of Medicine at Montpellier, and then to Paris. In 1781 he was appointed to the Chair of Chemistry founded by the States of Languedoc. Having been left a large fortune by his uncle, he originated a number of chemical manufactories in his adopted city, and thus raised in his own country products which previously were entirely derived from foreign lands. In 1793 he was called to Paris by the Committee of Safety, to manage the saltpetre manufactory. The great establishment of Grenelle became thus the scene of that zeal and industry which were so eminently illustrated during the whole of Chaptal's career. The Polytechnic School numbered him among its first professors. The Institute elected him in the place vacated by the death of M. Payen, and Napoleon, after the establishment of the Consulate, called him to the Council of State. In the year 9 he was made minister of the interior, and towards the end of the year 12 quitted his high functions. His ministry was distinguished by many signal benefits. He devoted much time to the examination of humane establishments, which, from the unfortunate state of the times, had been sadly neglected. He liquidated their debts, furnished them with new funds, regulated their administration, and instituted gratuitous commissions for governing them. At Paris a general council was instituted over these, which produced most important ameliorations in all the charitable establishments of the capital. The sisters of charity, so worthy of their name, who sympathize with the unfortunate, were recalled into the hospitals. Chaptal inspected the foundling hospitals, and endeavoured to prevent abuses in the admission of their inmates. He created houses of refuge in order to repress mendicity. He neglected no precaution for checking the small pox, by propagating vaccination, of which Larochefoucauld Liancourt destroyed the benefit. He originated the Vaccination Society, which exercised its salutary influence until it was suppressed by a bungling administration. He introduced hard labour in prisons, and adopted measures for improving the regulation of these domiciles. The interests of the public health likewise attracted his care. He revised and amended the laws relating to medicine and pharmacy; he organized lying-in hospitals, and regulated the exploring of mineral waters.

But, not the least of his attention was directed towards the advancement of the industry of his country; he established chambers of commerce, and consulting councils of arts and manufactures. The school of arts and the conservatory having become a great museum and an important seminary, are distinguishing marks of the care and anxiety which inspired him for increasing the opportunities and means of instruction. He published useful processes, visited the tradesmen, conversed with them, offered them his advice, praised their discoveries, and favoured processes and apparatus coming from abroad. His character has been drawn in high terms by Thenard: "Endowed with a kind heart, of a mild and gentle character, moderate in his tastes and opinions; full of benevolence to his fellow creatures, of affectionate regard for his associates, of devotion for his friends; ready to do a favour when in his power, and doubling it by the grace with which he conferred it; unhappy when obliged to refuse, and always softening the refusal by expressions which shewed the goodness of his heart. Possessing a handsome fortune, which he had nobly acquired, and loaded with honours, Chaptal appeared to have it in his power to foil the strokes of fortune. Yet some reverses and disappointments which he could not foresee, and certainly did not merit, tended to sadden the end of his brilliant career. But he knew how to support them with dignity. Not a murmur or sigh escaped from his lips, a proof, to the end, of the greatness of his mind. He consoled himself by study, and by fulfilling duties which had been imposed on him, or which he had created for himself. Then feeling his end approaching, he resigned himself like a philosopher prepared for leaving a world where he had but a few days to remain, and died beloved, surrounded by his numerous family, bestowing on them his blessing as his last farewell." He died at Paris 29th July 1832, in the 76th year of his age. At his death he was grand officer of the Legion of Honour. He was one of the first founders of the Society of Encouragement, over which he presided for many years. His principal works were

1. Elemens de Chimie, 3 vols. 8vo. The first edition appeared in 1790, the fourth in 1803. It was translated into most languages.

2. Essai sur le Perfectionnement des Arts Chemiques en France, 8vo. 1800.

3. Art de faire, de Gouverner et de Perfectioner les Vins, 8vo. first edition 1801, second 1811.

4. Art du Teinturier et du Degraisseur, 8vo. 1800.

5. Essai sur le Blanchîment, 8vo. 1801.

6. Chimie Appliquee aux Arts, 4 vols., 8vo. 1807.

7. Art du la Teinture du Coton en Rouge, 8vo. 1807.

8. De l'industrie Francaise, 2 vols., 8vo. 1819.

9. Memoire sur le Sucre de Betteravas, 8vo. first edition 1815, third 1821.

10. Chimie Appliquée a l'agriculture, 2 vols., 8vo. first edition 1823, second 1829.

11. Traité sur la Culture de la Vigne, 8vo. 1801.

ARTICLE II.

Chemical Analysis of Gadolinite, together with an Examination of some of the Salts of Yttria and Cerium. By THOMAS THOMSON, M.D., F.R.S., L. and E., &c., Regius Professor of Chemistry in the University of Glasgow; and ANDREW STEEL, M.D.

I. ANALYSIS OF GADOLINITE.

THE specimen of *gadolinite* which furnished materials for the experiments contained in this paper, was purchased several years ago from a German mineral dealer. He stated that he had accidentally observed it in a collection of minerals in Sweden, from the proprietor of which he procured it, and that its original locality was not certainly known. It weighed several ounces.

It was an amorphous mass, having a very deep green colour, so as to appear to the eye almost black.

The lustre on the fresh fracture was vitreous and splendent. But when broken in certain directions it presented a surface almost dull, and having a whitish aspect; but when viewed through a microscope no extraneous matter could be observed. The colour and want of lustre was probably owing to long exposure to the air, which had acted through certain natural rents in the mineral. For it broke with much more facility, so as to exhibit the dull than the splendent surface.

Hardness 6·5; specific gravity at 60° from 4·1493 to 4·1795. The mean was 4·1607.

Its other characters being the same as those of common gadolinite need not be described here. Twenty grains, by ignition, acquired a brownish colour, and lost 0·198 grains of weight, or almost one per cent. This loss was doubtless owing to the escape of water.

During the pounding of the mineral for analysis small metallic looking grains were observed, which were carefully picked out and submitted to the following examinations. They were malleable, infusible before the blowpipe, not acted on by muriatic acid, but dissolving slowly in aqua regia. The solution had a deep orange colour, a few blackish grains remaining at the bottom. It afforded a yellow precipitate with sal ammoniac and salts of potash and was obviously platinum. From 120 grs. of the mineral 2·33 grs. of platinum were picked out. But the quantity was found to vary in different pieces.

We attempted to analyze gadolinite by the processes employed by Berzelius. But we found that the peroxide of iron, which we had precipitated by benzoate of ammonia, contained also glucina, from which we could not separate it by means of benzoate of ammonia however carefully added. This led us to a careful investigation of the properties of cerium, yttria, and glucina. The facts ascertained suggested the following method of analyzing gadolinite :—

A. 25 grs. of the mineral, finely pounded, were boiled in a flask with aqua regia, till the whole was decomposed. The gelatinous silica remaining, collected on a filter, and well washed, weighed, after ignition, 6·22 grs.

B. The residual liquid was evaporated to dryness, and the solid matter remaining, digested for some time in distilled water. A solution of oxalic acid was then added, as long as it occasioned a precipitate, and until this precipitate was of a perfectly white colour. The oxalic acid retained in solution the iron, glucina, &c., and threw down the yttria and cerium in the state of oxalates. The whole was thrown upon a filter, and the white insoluble matter was well washed. When dry it was a beautiful light, snow-white powder, and weighed, after ignition, 12·617 grs. It had now assumed a light yellow colour, and was a mixture of oxide of cerium and yttria.

Various methods of separating these two substances from each other were tried, but without success, on account of the perfect correspondence of the two in all their properties, We were, therefore, obliged to have recourse to the common method of putting a quantity of solid sulphate of potash into a neutral solution of the yttria and oxide of cerium, which threw down the cerium and left the yttria. But as the quantities were never absolutely the same in two successive experiments, this method is certainly suspicious. By this method the 12·176 grs. were resolved into

Yttria	11·087	
Peroxide of cerium . .	1·530	= 143 protoxide.
	12·617	

C. The oxalic solution from (B.) was evaporated to dryness, and ignited to destroy the oxalic acid. The residue was dissolved in muriatic acid, by the assistance of heat, with the exception of a few blackish grains. These were at first supposed to be charcoal from the oxalic acid, but after being collected and ignited they proved to be platinum, weighing 0·45 grs.

D. The muriatic acid solution was now evaporated to dryness, and to insure perfect neutralization, heated, so that a small portion of the iron became insoluble on its being again digested in water. Into this muddy liquid a quantity of benzoic acid was thrown, and well stirred. After standing 24 hours the whole iron was found to be precipitated, while the glucina remained in solution.* The benzoate of iron was collected on a filter, washed, dried, and ignited. The peroxide of iron obtained weighed 3·75 grs. = 3·375 protoxide. On trial it appeared perfectly pure.

E. The residual solution was now mixed with ammonia, which threw down a white floculent precipitate. It was collected on a filter, well washed and dried. After ignition it had a dirty brownish white colour, and weighed 3·182 grs.

It dissolved in acids, forming very sweet tasted salts. The sulphuric acid solution crystallized, though imperfectly. The solution gave the following characters with re-agents:

Prussiate of potash: No precipitate.

Caustic ammonia: A white precipitate, not soluble in an excess of the ammonia.

Carbonate of ammonia: White precipitate, soluble in an excess of the alkali.

Caustic of potash: A white precipitate, soluble in an excess.

Oxalic acid: No precipitate.

Oxalate of ammonia: No precipitate.

Benzoate of ammonia: No precipitate.

Tincture of nutgalls: A white precipitate.

Gallic acid: No precipitate.

The white matter obtained was therefore glucina.

The preceding analysis gave the constituents of gadolinite as follows:—

Silica	6·220	-	24·880
Yttria	11·087	-	44·348
Protoxide of cerium	1·430	-	5·720
Glucina	3·182	-	12·728
Protoxide of iron	3·375	-	13·500
Platinum	0·450	-	1·800
Moisture	0·247	-	1·088
	25·991	-	104·064

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* It had been ascertained by experiment that benzoate of ammonia throws down glucina, which benzoic acid does not; and that, with care, the peroxide of iron may be completely thrown down by benzoic acid.

Suspecting that the increase of weight in this analysis, which rather exceeds 4 per cent., might have been owing to the yttria not having been sufficiently ignited,* it was repeated in the following manner:—

A. 30 grs. of the finely powdered mineral were boiled in a flask with nitro-muriatic acid till the whole was decomposed. The silica separated in the usual way, and most carefully washed with boiling distilled water, weighed, after ignition, 7·3 grs. It was beautifully white and pure.

B. The residual solution was mixed with sal-ammoniac, and evaporated to dryness. When again dissolved only a mere trace of platinum remained.

C. The solution was now mixed with oxalic acid, and, to ensure the precipitation of any manganese that might exist in the mineral, the whole was evaporated to dryness. The white matter remaining undissolved on digesting the mass in water, after being well washed and ignited, weighed 15 grs. It was of a light-yellow colour.

D. It was dissolved in nitric acid. The solution was evaporated to dryness, the residue dissolved in a small quantity of water, and crystals of sulphate of potash were allowed to remain in the solution for a week. The clear liquid was then drawn off, and the white matter, after being well washed in a saturated solution of sulphate of potash, was dissolved in dilute nitric acid, and precipitated by ammonia, and boiled in a flask, to ensure the complete separation of the sulphuric acid. The peroxide of cerium, after ignition, weighed 1·400 grs. = 1·3 grs. protoxide.

E. The sulphate of potash solution from (D) was mixed with a solution of carbonate of ammonia in great excess. To what remained after the clear liquid had been drawn off fresh solutions were added, and this was repeated six times before the whole was dissolved. There remained only a few flocks, not weighing 0·01 gr. As they became black when dried they probably consisted of oxide of manganese, but the quantity was too small to permit the use of re-agents to determine its nature.

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* We had found that the carbonate of cerium is not decomposed by exposure to a pretty strong red heat.

The 15 grs. of white matter were therefore composed of

Yttria	13·6
Peroxide of cerium .	1·4
Manganese . . .	trace
	15·0

F. The oxalic solution from (C.) was precipitated by ammonia, and the precipitate washed to get rid of the oxalic acid. It was then dissolved in muriatic acid. To separate the glucina from the iron, caustic potash, and then carbonate of ammonia were tried; but neither of these methods was found to answer. The separation was therefore accomplished by the same process as in the former analysis. There were obtained

Peroxide of iron . . .	4·53 = 4·077 protoxide
Glucina	3·47

This analysis gives the composition of gadolinite as follows:—

Silica	7·300	24·33
Yttria	13·600	45·33
Protoxide of cerium . .	1·300	4·33
Glucina	3·470	11·60
Protoxide of iron . . .	4·077	13·59
Platinum	trace	trace
Manganese	trace	trace
Moisture	0·296	0·98
	30·043	100·17

This analysis gives us the constituents of gadolinite as follows:—

12·16	atoms silica
8·06	,, yttria
0·88	,, protoxide of cerium
3·91	,, glucina
3·	,, protoxide of iron.

Were we to suppose the protoxide of iron to be an accidental ingredient, we might consider gadolinite as composed of 2 atoms silicate of yttria,
1 atom silicate of glucina and cerium,

or we might consider it as composed of

1 atom silicate of cerium,
4 atoms silicate of glucina,
8 ,, silicate of yttria.

If the protoxide of iron be an essential constituent, the oxide of cerium, glucina, and protoxide of iron must be in the state of disilicates.

II. EXPERIMENTS ON YTTRIA.

The neutral colourless sulphate of yttria was dissolved in water, and the solution, when treated by re-agents, exhibited the following properties:—

1. Prussiate of potash: A white chalky precipitate.
2. Ammonia: A white precipitate, not soluble in excess.
3. Potash: A white precipitate, not soluble in excess.
4. Alkaline carbonates: A white precipitate, soluble in excess.
5. Infusion of nutgalls: O.
6. Gallic acid: O.
7. Tincture of nutgalls: White, merely from the alcohol.
8. Alcohol: White.
9. Chromate of potash: Yellow.
10. Bichromate of potash: O.
11. Hydriodate of zinc: O.
12. Sulphate of potash: O.
13. Oxalic acid: A white precipitate.
14. Oxalate of ammonia: A white precipitate.

When a solution of muriate of yttria was exposed to the galvanic action, chlorine was given out at the negative pole, and a small quantity of some other gas, (probably hydrogen) at the positive pole. A quantity of gelatinous matter collected round the negative wire.

Yttria is not altered by having a current of sulphuretted hydrogen passed over it while heated to redness in a green glass tube.

When phosphorus in vapour is passed over yttria heated to redness, a vivid ignition takes place, but no combination is formed. The weight of the yttria remains unaltered.

III. SALTS OF YTTRIA.

1. *Sulphate.*—Sulphuric acid acts with considerable violence on anhydrous yttria, and with the evolution of considerable heat. The solution crystallizes in doubly oblique prisms, and also in acute rhomboids.

The taste is sweet and astringent, and the crystals are insoluble in alcohol.

100 parts of water, at the temperature of 65° dissolve very nearly 7·19 grs. of the crystallized salt.* The sp. gr. of the salt is 2·565. It reddens vegetable blues. It may be exposed to a gentle heat without decomposition, but is partly decomposed at a higher temperature.

12·8 grs. of the crystals lost, when dried at the highest temperature of the sand-bath, 3·00 grs. The crystals had not lost their shape, but had become opaque, and of a pearl white colour. They were dissolved in water, and mixed with a solution of muriate of barytes. The sulphate of barytes weighed, after being well washed and ignited, 13·6 grs. = 4·869 grs. of acid. This gives the composition of the salt,

Yttria	5·111	or	5·45
Sulphuric acid . .	4·689	,,	5·
Water	3·000	,,	3·19
	12·800		

This analysis was repeated with the following result:—

18·62 grs. of the crystals lost, by exposure to a gentle heat, 33·2 grs. The beautiful pearl white residuum dissolved completely in water. The acid was precipitated by nitrate of lead, giving 27·30 grs. of ignited sulphate of lead = 7·18 grs. of sulphuric acid. The residual liquid was freed from excess of lead by sulphuric acid, and the yttria precipitated by ammonia. It weighed, after ignition, 8·0 grains. This analysis gives,

Yttria . . .	8·00	or	5·59
Acid . . .	7·18	,,	5·
Water . . .	3·32	,,	2·31
	18·50		

A third repetition of the analysis was made as follows:—

30 grs. of the crystals, purified by washing in alcohol, to free them as much possible from hygrometic moisture, were heated on the sand-bath for 12 hours, and then gently ignited. The loss of weight was 6·7 grs. The residual salt dissolved completely in water. The yttria was precipitated

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* An excess of the salt was shaken on the sand-bath occasionally for three days, 306 grs. of this solution left, when evaporated, 22 grs. of the crystallized salt.

by oxalate of ammonia. The oxalate collected on a filter, well washed and ignited, left 12·257 grs. of yttria. The residual liquid, after being mixed with a little nitric acid, was precipitated by chloride of barium. The sulphate of barytes obtained, weighed, after ignition, 32 grs. = 11·03 grs. of sulphuric acid. This analysis gives,

Yttria	12·257	or	5·54
Sulphuric acid . .	11·030	,,	5·
Water	6·700	,,	3·04
	29·987		

These three analyses, corresponding so closely in the proportion of acid to base, leave little doubt that the atomic weight of the base in this salt is as high as 5·5. If the yttria employed by Berzelius contained glucina, it will account for his finding it less. Probably the true composition is,

Yttria	5·5
Sulphuric acid . .	5·
Water	2·25
	12·75

To verify this, solutions of 12·75 sulphate of yttria, 8·875 oxalate of ammonia were mixed. The residual liquid was neither altered by sulphate of yttria nor oxalate of ammonia. But when the residual liquid was evaporated nearly to dryness, it was found to give traces of yttria by prussiate of potash. It was mixed with caustic ammonia, which threw down a small quantity of yttria, weighing 0·32 grs. The oxalate collected on a filter and washed, left, when ignited, 5·1 grs. of yttria. 8·875 grs. of oxalate of ammonia, therefore, do not decompose completely 12·75 grs. of sulphate of yttria. Probably because the oxalate was not quite dry.

Solutions of 12·75 grains sulphate of yttria,
,, 20·75 ,, nitrate of lead,

were mixed. The supernatant liquid was neither affected by sulphate of soda nor nitrate of lead. For greater certainty, it was divided into two portions: into the one was poured nitrate of lead, and into the other sulphate of soda. After standing 24 hours, a mere trace of opacity was perceptible at the bottom of the vessel, to which the nitrate of lead had been added.

No *bisulphate of yttria* could be formed. When we evaporate a solution, containing even a considerable excess of acid, common sulphate of yttria is obtained.

2. *Acetate of yttria.*—This salt crystallizes in beautiful rhombs. It has a sweet taste and is not altered by exposure to the air.

10·58 grains of the crystals heated on the sand-bath, fell to a white powder and lost 2·14 grains. After ignition, the yttria remaining weighed 3·92 grains. Hence, its constituents are,

Yttria . . .	3·92	or 5·5
Acetic acid . .	4·52	,, 6·341
Water	2·14	,, 3·000
	10·58	

In a second analysis, 9·2 grains lost on the sand-bath 2·05 grs., and after ignition there remained 3·35 grs. of yttria. Hence, it was composed of,

Yttria	3·38	or 5·5
Acetic acid . .	3·80	,, 6·238
Water	2·05	,, 3·365
	9·2	

These analyses shew that the salt is composed of

1 atom yttria	5·5
1 atom acetic acid . . .	6·25
3 atoms water	3·375

3. *Oxalate of yttria.*—Oxalic acid seems to combine in various proportions with yttria. The oxalates, however, have all the same beautiful snow-white colour. They appear to be quite insoluble in water; but after being once or twice washed on a filter, the liquid begins to pass through muddy.

1*st*. 11·38 grs. of anhydrous sulphate of yttria gave by oxalate of ammonia, 12·9 grs. of oxalate of yttria, which, when ignited, left 5·97 grs. of yttria.

2*nd*. 10 grs. of yttria dissolved in muriatic acid gave 22·4 grs. of oxalate of yttria.

3*d*. 30·04 grs. of oxalate of yttria, dried as well as possible, left, after ignition, 12·422 grs. of yttria.

These experiments seem to prove that the neutral oxalate is a compound of,

1 atom yttria . . .	5·5
1 atom oxalic acid .	4·5
2 atoms water . . .	2·25
	12·25

Sesqui-oxalate of yttria.—When, instead of precipitating the sulphate of yttria by the oxalate of ammonia, we reverse the process, the precipitate is a sesqui-oxalate, as the following experiments shew:—

1*st.* 8·875 grs. of oxalate of ammonia were dissolved in water, and a solution of sulphate of yttria was added as long as it occasioned a precipitate. The precipitate being collected on a filter, and well washed and dried, weighed 9·43 grs. and after ignition 4·008 grs. of yttria remained.

2*nd.* The same experiment being repeated, gave 9·9 grs. of oxalate, leaving, after ignition, 4·092 grs. of yttria.

Now, since 8·875 grs. of oxalate of ammonia contain 4·5 grs. of oxalic acid, we have from

	1*st. experiment:*		2*nd experiment:*
Yttria .	4·008 or 5·5	-	4·092 or 5·5
Acid .	4·5 ,, 6·	-	4·5 ,, 6·

This is nearly 1½ atom acid to 1 atom base.

Dinoxalate of yttria.—When yttria is precipitated from a solution containing an excess of acid, by oxalic acid, we sometimes obtain the neutral oxalate, but occasionally another compound, which, however, has exactly the same appearance.

12·55 grs. of this, on ignition, left 9·45 grs. of yttria. Hence, it seems to have been composed of,

2 atoms yttria . .	1·1
1 atom acid . . .	4·5
Water	0·28

Doubtless hygrometrical.

4. *Nitrate of yttria.*—When nitric acid is poured upon yttria, no immediate action takes place; but, if the mixture be gently heated the yttria dissolves at once, with the evolution of nitrous gas. When evaporated the salt crystallizes in prisms. When gently heated it melts into a beautiful transparent glass, and is completely decomposed by a very slight heat. It is very deliquescent.

An analysis of the crystals offered very unsatisfactory results, from the impossibility of drying them. 10 grs. lost, when ignited, 6·56 grs. 5·5 grs. of yttria were dissolved in pure nitric acid, and heated until the whole fused into a transparent glass. The weight had increased to 12·4 grs. It was again heated till the glass began to get opaque, it now weighed 11·72 grs. But a considerable portion of it was insoluble in water, evidently shewing that some of the acid had been driven off. If the salt was neutral, (as must have been the case,) the first experiment leads to the conclusion that its constituents are,

Yttria . . .	5·5	or 1 atom.
Nitric acid .	6·5	,, 1 atom.
Water . . .	2·25	,, 2 atoms.
	14·25	

5. *Muriate of yttria.*—Muriatic acid dissolves yttria very readily. The solution, when carefully evaporated, crystallizes in large right prisms, with two opposite angles, truncated so as to constitute six-sided prisms. The taste is sweet and astringent. The crystals are very deliquescent. When heated the salt undergoes the watery fusion, and is decomposed at a red heat.

Its analysis did not afford very satisfactory results, as, from its easy decomposition and rapid deliquescence, it is exceedingly difficult to free the crystals from the mother liquor.

10 grs. of the crystals lost, when dried on the sand-bath, 2·37 grs. The residue did not dissolve completely in water, indicating that some of the acid had been driven off. The yttria, precipitated by ammonia, weighed 4·08 grs., and the residual solution, after being neutralized by nitric acid, gave 11·59 grs. of fused chloride of silver = 2·93 grs. of muriatic acid. This gives the constitution of the salt,

Yttria . . .	4·08	or 5·5
Muriatic acid .	2·93	,, 3·94
Water . . .	2·37	,, 3·1

In another analysis, 15·65 grs. of the crystals dissolved in water, gave 19·881 grs. of chloride of silver, = 5·04 grs. acid; and by ammonia, 5·21 grs. of yttria. This gives us:—

Yttria . . .	5·21	or	5·5
Muriatic acid .	5·04	,,	5·37
Water . . .	5·40	,,	5·5

The mean of these two analyses gives us the following constituents :—

Yttria	5·5
Muriatic acid .	4·65
Water	4·3

This, though not quite accurate, comes near enough to shew that the salt contains an atom of acid, united to an atom of base. If it be a chloride, as is probable, then its constituents are,

1 atom yttrium . . .	4·5
1 atom chlorine . . .	4·5
5 atoms water . . .	5·625

6. *Carbonate of yttria.*—Yttria has considerable affinity for carbonic acid, even when precipitated by caustic ammonia. For, when dried in the open air it is partially converted into a carbonate. Carbonate of yttria is a white tasteless powder, insoluble in water, but soluble in the alkaline carbonates. When a solution of yttria, in an alkaline carbonate, is heated, the yttria is precipitated in the state of a carbonate, but is again dissolved when the solution cools.

6·2 grs. of this carbonate lost, by a red heat, 2·53 grs. Hence, its constituents were,

Yttria . . .	3·67	or	5·5
Carbonic acid .	1·83	,,	2·75
Water . . .	0·70	,,	1·05
	6·20		

Through a quantity of freshly precipitated carbonate of yttria, suspended in water, a current of carbonic acid gas was passed for a considerable time, without any alteration. Hence, we have no evidence of the existence of a bicarbonate of yttria.

7. *Tartrate of yttria.*—A beautiful light white powder, obtained by precipitating sulphate of yttria by tartrate of potash. 5·2 grs. of it lost, by ignition, 3·26 grs. This would indicate for its composition :

Yttria . . .	1·94	or	5·5
Tartaric acid .	2·96	,,	8·25
Water	0·36	,,	1·02

8. *Phosphate of yttria.*—Phosphoric acid does not dissolve yttria, but the phosphate may be obtained by precipitating sulphate of yttria by phosphate of soda. The salt falls in gelatinous flakes, having, when on the filter, much the appearance of hydrate of alumina. After ignition it still retains its opalescent appearance, but becomes more compact, and of a vitreous lustre, though the particles are not agglutinated.

9·8 grs. of anhydrous sulphate of yttria gave 9·72 grs. of hydrous phosphate, reduced by a red heat to 7·92 grs. Now, as 9·8 grs of sulphate contain 5·133 grs. of yttria, we have the constituents,

Yttria	5·133	or	8·25	-	1½ atoms.
Phosphoric acid . .	2·786	,,	4·477	-	1 ,,
Water	1·800	,,	2·8	-	2½ ,,
	9·719				

It is, therefore, a disesquiphosphate, apparently similar to the native disesquiphosphate.

IV. OF CERIUM.

Cerium, as is well known, forms two oxides. We did not succeed in our attempts to obtain the protoxide in a separate state, but the salts containing it are readily formed. The peroxide has a yellow or brown colour, according to the mode in which it is obtained. Both oxides form salts with acids. The salts containing the protoxide have an amythystine colour, and are quite permanent. Those containing the peroxide are yellow, or orange, and easily decomposed. The sp. gr. of the peroxide of cerium is 5·33.

The protoxide of cerium, when in the state of sulphate, may be distinguished by the following characters:

Prussiate of potash: A white chalky precipitate.

Ammonia: A white gelatinous precipitate, not soluble in an excess of ammonia.

Potash: A white precipitate, insoluble in an excess.

Alkaline carbonates: A white precipitate, soluble in an excess, but precipitated again when boiled.

Infusion of nutgalls: O.
Gallic acid: . . . O.
Tincture of nutgalls: White, merely from the alcohol.
Chromate of potash: A yellow precipitate.
Bichromate of potash: O.
Hydriodate of zinc: O.
Sulphate of potash: No immediate action.
After some time a copious white powder falls.
Oxalate of ammonia: A white powder.
Oxalic acid: A white curdy precipitate
Phosphate of soda: A white precipitate.
Tartrate of potash: A white precipitate.

V. SALTS OF CERIUM.

1. *Sulphated protoxide.*—This salt may be obtained by dissolving peroxide of cerium in sulphuric acid, and adding a little muriatic acid. Chlorine is given off, and a colourless solution obtained, which when sufficiently concentrated yields prismatic crystals of an amythystine colour. When alcohol is added to the concentrated solution, the salt falls in fine silvery needles: its taste is agreeably sweet and astringent. Its specific gravity is about 2·5: 100 parts of water at the temperature of 60°, dissolve 6·47 of the crystallized salt. When heated, it becomes white and opaque, but cannot be rendered anhydrous without losing a little of its acid. After having been once or twice crystallized it is quite neutral.

The analysis of this salt was attended with unexpected difficulty. It was not till after a considerable waste of time and matter, that the varying results were found to arise from the formation of various double salts. When the acid was thrown down by barytes, the sulphate obtained after the most careful washing, contained abundant traces of cerium. When ammonia was employed to throw down the oxide, a subsalt fell, and the acid being driven off from this salt by a red heat, gave an apparent loss, and rendered the results quite unintelligible.

I. 12·75 grains of the crystallized salt lost by a gentle ignition 1·6 grain; the residuum dissolved completely in water; the cerium was thrown down by oxalate of ammonia. The oxalate was collected on a filter, well washed with boiling distilled water, dried and ignited: 6·58 grains of peroxide of cerium were obtained. From the residual solution mixed with nitric acid, the sulphuric acid was thrown down by means of chloride of barium. The well washed sulphate weighed after ignition 13·36 grs.=4·6 grs. sulphuric acid. This analysis gives us,

Peroxide of cerium . . .	6·58	or 7·15
Sulphuric acid	4·60	,, 5·
Water	1·90	
	13·08	

Increase of weight by peroxidizing the cerium 0·33 gr.

II. 20 grs. of the salt in small silvery needles when exposed to a low red heat lost 4·67 grs. The remainder dissolved completely in water. The solution was mixed with nitric acid, and after a sufficient quantity of muriate of barytes had been added, the whole was boiled in a flask, the sulphate collected, well washed and dried weighed 20·05 grs., reduced by ignition to 18·967 grs.=6·54 grs. of sulphuric acid.

Other 20 grs. of the salt treated in the same way, but substituting muriatic for nitric acid gave 18·86 grs. of sulphate of barytes=6·51 grs. sulphuric acid; the mean of these two trials gives us 6·52 grs. of sulphuric acid from 20 grs. of the salt.

20 grs. of the same needles gave by oxalate of ammonia 19 grs. of hydrous oxalate, leaving after ignition in a close crucible a yellow powder, weighing 9·27 grs. When the ignition was repeated in an open crucible, the weight was not altered, but the colour became red. This analysis gives us

Peroxide of cerium . . .	9·27	or 7·10
Sulphuric acid	6·52	,, 5·
Water	4·67	,, 3·5
	20·46	

Here the increase of weight from the peroxidizement of the cerium is 0·46 gr.

III. 19 grs. of the same crystals lost by gentle ignition 4·20 grs. The residuum was introduced into a flask and boiled with a solution of carbonate of ammonia, and filtered while boiling hot. The carbonate of cerium after careful washing weighed when dry 10·7 grs. Being exposed to a strong red heat, it left 8·89 grs. of peroxide of cerium.

The residual solution was mixed with nitric acid in excess and precipitated by chloride of barium. The sulphate of barytes collected on a filter, well washed, dried and ignited weighed 18·53 grs.=6·42 grs. of sulphuric acid. This analysis gives,

Peroxide of cerium . . .	8·893	or	6·92
Sulphuric acid	6·420	,,	5·
Water	4·2	,,	3·25
	19·513		

Increase of weight by the peroxidizement of the cerium, 0·513 grs.

These analyses give as the atomic weight of the peroxide of cerium,

1st. . . .	7·15
2nd. . . .	7·10
3d. . . .	6·92
Mean .	7·05

This mean comes so near 7 as to leave little doubt that it is the true number. The increase of weight of the oxide in each analysis comes very near half an atom of oxygen. The reason why it is not exactly so, is that we were unable to render the salt perfectly anhydrous, without decomposition. It is pretty evident then that the atomic weight of protoxide of cerium is 6·5, and that the true composition of cerium is doubtless,

1 atom protoxide . . .	6·5
1 atom sulphuric acid .	5·
3 atoms water	3·375
	14·875

2. *Sulphated Peroxide of Cerium.*—This salt may be obtained by dissolving peroxide of cerium in dilute sulphuric acid by a gentle heat. The solution takes place slowly. The orange coloured solution thus formed, when cautiously evaporated, yields beautiful silky needles of a lemon-yellow colour. When alcohol is added to the concentrated solution the salt falls down exactly like a piece of soft yellow resin, very adhesive, not exactly deliquescent, but becoming softer when exposed to the air.

The crystals are quite permanent in the air. When dissolved in a small quantity of water they are decomposed into a solution of sulphated protoxide, and a yellow insoluble subsalt, which precipitates. The sulphated peroxide of cerium reddens vegetable blues. When heated it melts into an orange coloured liquid, which becomes yellow when all the water is driven off. A red heat decomposes the salt altogether.

20 grs. of this salt were digested in a flask with a large quantity of distilled water. The solution was perfectly colourless, but a yellow powder remained at the bottom. It was collected on a filter, well washed with boiling distilled water, and dried. It weighed 2·7 grs., but after exposure to the highest temperature of the sand-bath, it was reduced to 2·362. By analysis it was found a disulphated peroxide of cerium composed of

Peroxide of cerium	1·742
Sulphuric acid	0·621
	2·363

The residual colourless solution was reduced by evaporation to a convenient bulk, and boiled in a flask with a solution of carbonate of ammonia. The precipitated carbonate of cerium, after being well washed and dried, weighed 8·9 grs., and after ignition the weight was 5·33 grs.

The residual solution, after being mixed with nitric acid in excess, was precipitated by chloride of barium. The sulphate of barytes, after washing and ignition, weighed 19·95 grs. = 6·87 grs. of sulphuric acid. This analysis gives us,

Peroxide of cerium	5·33	or 7·072	1 atom.
Sulphuric acid	6·87	,, 7·491	1½ atoms
Disulph. peroxide	2·362	,,	
Water	5·438	,, 5·438	5 atoms.
	20·		

Thus, it appears that the salt was a sesquisulphated peroxide of cerium containing 5 atoms of water.

3. *Disulphated protoxide of Cerium.*—A white insoluble powder obtained when the sulphate of cerium is thrown down by ammonia. It is composed of,

Protoxide of cerium	13·	or 2 atoms.
Sulphuric acid	5·	,, 1 atom.
Water	2·1	,, 2 atoms.

4. *Disulphated peroxide of Cerium.*—A sulphur yellow, insoluble powder, obtained by dissolving sesquisulphated peroxide of cerium in water. When heated it becomes white, and reddish by a gentle ignition. Before ignition it dissolves easily in acids, but after being heated to redness it is not acted on by nitric, muriatic, or nitro-muriatic acids.

2·18 grs. of the yellow salt were dissolved in a flask with muriatic acid. Carbonate of ammonia was then added, and the mixture boiled. The precipitated carbonate collected and well washed, left, after ignition, 1·28 grs. of peroxide of cerium.

The residual solution mixed with nitric acid gave 1·305 grs. of sulphate of barytes = 0·45 sulphuric acid. This analysis gives us,

Peroxide of cerium . . .	1·28	or	14·4
Sulphuric acid	0·45	,,	5·
Water	0·45		
	2·18		

As nearly 2 atoms of oxide as could be expected from an analysis on so small a scale.

5. *Potash-sulphate of Cerium.*—A granular white powder, scarcely soluble in water, but easily so when a little acid is added.

18·9 grs. of the salt, previously gently ignited, were dissolved in a flask in dilute muriatic acid. Carbonate of ammonia was then added; the mixture was boiled, and filtered while boiling hot. The carbonate of cerium, after being well washed, weighed 9·5 grs. reduced by a strong ignition to 6·00 grs. peroxide = 5·57 grs. protoxide.

From the residual solution, mixed previously with nitric acid, the sulphuric acid was thrown down by barytes. The ignited sulphate weighed 23·467 grs. = 8·23 grs. sulphuric acid.

The residual solution, the excess of barytes having been removed by sulphuric acid, was evaporated to dryness and ignited, mixed with carbonate of ammonia and again ignited. The sulphate of potash remaining, weighed 9·53 grs. = 5·20 grs. of potash. This analysis gives,

Protoxide of cerium . .	5·57	or	6·5	-	1 atom.
Potash	5·20	,,	6·06	-	1 atom.
Sulphuric acid	8·23	,,	9·6	-	2 atoms.

A little sulphuric acid may have been driven off by the previous ignition. The result is, however, sufficiently near to prove the composition of the salt to be,

1 atom sulphate of cerium . .	11·5
1 ,, ,, potash . .	11·0
	22·5

6. *Potash-sesquisulphated peroxide of Cerium.*—A beautiful yellow powder, becoming white when washed or heated.

4·8 grains lost by gentle ignition 0·5 grs. The residue was dissolved in muriatic acid, and the oxide of cerium was thrown down by ammonia. The remaining liquor evaporated to dryness, left 1·8 grs. of sulphate of potash.

It is clear from this that the salt is a compound of,

1 atom sesquisulphated peroxide of cerium,
1 atom sulphate of potash.

7. *Oxalate of Cerium.*—This salt may be obtained by adding either oxalic acid or oxalate of ammonia to a solution of sulphate of cerium. When oxalic acid is used the salt falls down like a piece of curd, perfectly white, and it may be taken out of the vessel in a lump on the end of a glass rod. It is very adhesive and plastic, exactly like so much soft resin. Whether allowed to remain in the solution or dried, it rapidly loses this property, and falls to a white powder. When heated it burns and leaves pure peroxide of cerium.

After having been dried in the highest temperature it could bear without charring, 28·15 grs. left, on ignition, 17·9 grs. of peroxide = 16·62 protoxide. Supposing the salt to have been perfectly anhydrous, we have its composition,

Protoxide of cerium . .	16·62	or 6·492	- 1 atom.
Oxalic acid	11·53	,, 4·5	- 1 ,,
	28·15		

8. *Sesqui-oxalated peroxide of Cerium.*—This salt may be obtained from the solution of the peroxide, exactly in the same manner as the last salt. The adhesive matter obtained is reddish-yellow, instead of white, but it falls into a white powder when dried.

20·6 grs. digested in caustic potash for 12 hours left 10 grs. of peroxide of cerium. The weight was not altered by nitric acid. The residual liquid containing the oxalic acid was accidentally lost; but, from the preceding experiment, we may deduce the composition of the salt as follows :—

Peroxide of cerium . . .	10·	or 7·	-	1 atom.
Oxalic acid	9·57	,, 6·75	-	1½ atoms.
Water	1·03	,, 0·75	-	½ atom.
	20·6			

9. *Disesqui-phosphate of Cerium*—8·3 grs. peroxide = 7·7 grs. protoxide of cerium were digested in muriatic acid, and the solution evaporated to dryness. The white matter remaining after being again dissolved in water was precipitated by phosphate of soda. The white precipitate collected on a filter, well washed and dried, weighed 12·2 grs., reduced by ignition to 11·09 grs. Its colour had now become greenish-yellow. It was hard, compact, and semivitreous, but without the least appearance of having been fused.

It is obvious that the constituents of this salt are,

Protoxide of cerium . .	7·70	or 10·22	-	1½ atoms.
Phosphoric acid . . .	3·39	,, 4·5	-	1 atom.
	11·09			

10. *Disesqui-phosphated peroxide of Cerium.*—10 grs. of peroxide of cerium were dissolved in nitric acid, and gently evaporated to dryness. The red mass obtained was dissolved in water, and precipitated by phosphate of soda. The precipitate, which was slightly yellow, was collected on a filter, well washed and dried. It weighed 16·42 grs. reduced by ignition to 14·23 grs. It had exactly the colour, lustre, and appearance of the preceding salt.

Its constituents were

Peroxide of cerium . . .	10·	or 10·63
Phosphoric acid . . .	4·23	,, 4·5

This is obviously 1½ atoms of peroxide of cerium, and 1 atom phosphoric acid. Thus, in its constitution, it agrees with the former salt. The only difference between them being the different states of oxidizement of the cerium.

The preceding experiments were made with a view of determining the atomic weights of yttria and cerium with more accuracy than could be done formerly, when the experiments were made upon only a few grains of each. The specimen of gadolinite employed weighed several ounces, and enabled us to procure such quantites, both of yttria and oxide of cerium, that we were enabled to repeat our experiments till we satisfied ourselves of their near approach to accuracy. The preceding account contains the most material facts which we ascertained. The experiments themselves occupied several months, and would have occupied a great deal of room had we thought it requisite to detail them at full length.

ARTICLE III.

Examination of Lymph, Blood, and Chyle. By JOHN MÜLLER, M.D. *Professor of Physiology in the University of Bonn.* (*Poggendorff's Annalen*, Band xxv. 513.)

IN the winter of 1831-32, a favourable opportunity occurred at Bonn for examining human lymph. Professor Wutzer had a young man under his care with a wound of some standing on the upper part of the foot. When pressure was made on the back of the great toe, in the direction of the wound, a clear liquid spouted out, which was lymph. In the course of 10 minutes it deposited a cobweblike coagulum of fibrine. According to Reuss, Emmert, Sömmering, and other late observers, the lymph contains no globules. Hewson, however, in the lymph from the thymus gland of the calf, discovered numerous white globules, and in the reddish lymph of the spleen, red globules. Dr. Nasse and Hrn Müller, by means of the microscope, appear to have established the same fact in reference to human lymph. In clear, transparent lymph, they observed a number of colourless globules, which seem smaller and less abundant than the globules of human blood. Part of these globules is included in the coagulum, but the greatest portion remains suspended in the serum of the lymph. It is to be remarked that the coagulum is not formed by the accumulation of the globules, but it may be easily perceived that a substance previously in solution coagulates, and takes up part of the globules. These globules may be more distinctly seen in the coagulum, when a small portion of the lymph is placed in a watch glass, and allowed to stand. The glass magnifies the globules, and permits their presence to be demonstrated. The substance which unites the globules may be observed on the edge of the coagulum to be homogeneous, slightly translucent, and does not appear to consist of globules, but, if globules are contained in it, they must be greatly inferior in size to those of the lymph. These observations shew that although the lymph contains globules suspended in it, yet the fibrine is held in solution.

It is more easy to obtain lymph from the inferior animals for the purposes of experiment than it is to procure human lymph. Pure lymph can be collected in considerable quantity from a large frog, by separating the skin from the muscles, with the precaution of avoiding to injure the blood vessels. A liquid flows out which deposits a coagulum when placed at rest for a few minutes. In 81 parts of the lymph of the frog is contained 1 part of dry fibrine. Coagulation is prevented by allowing the frog to fast for a long time before collecting the lymph. Fresh lymph from the frog contains globules, thinly scattered through it. These are round and smaller than the elliptical globules in the blood of the frog.

According to the experiments of Müller, by the addition of a concentrated solution of caustic potash, albumen is separated not only from the lymph of the frog but also from the chyle of mammalia, and from small quantities of the serum of the blood. Lymph is generally colourless. Hewson, Tiedemann, and Gmelin, have remarked that it is often reddish in the lymph vessels of the spleen, which Rudolphi considered accidental. Hewson attributed this colouring to the presence of the red globules of the blood, an opinion which must be received cautiously, because, under the microscope, the globules of the blood do not at once appear red.

Little is known with regard to the mode in which the lymph is carried into the circulation, for no contraction has hitherto been detected in the lymphatic ducts. Müller, however, has observed in the frog a double contractile organ, lying on each side behind the hip joint, on the side of the rectum, in the ischiatic region, which appears to have great influence on the propulsion of the lymph. The rythmus of the contraction of this organ is peculiar, being neither synchronous with the heart nor respiration, nor with each other, and can be readily perceived when viewed posteriorly through the skin, and very distinctly when the skin is removed. Under this organ lie a large vein and artery, whose circulation, however, has no influence upon the organ. The organ itself is oblong, and contains a clear colourless liquid, which flows out when an incision is made; and if we inflate it downwards, not only are the vessels of the thigh and leg filled, but likewise some of those of the trunk. When inflation is made upwards a lymphatic duct leading to the back is filled. It may be remarked, that by inflating the organ, the whole veinous system, as well as the lymph vessels, are filled with air, which would go to demonstrate the existence of an intimate connexion between these two sets of vessels. The same lymphatic apparatus was detected in the toad, similarly situated as in the frog, and in the salamander and green lizard, on the side at the root of the tail, close behind the extremity of the rectum. Dr. Marshall Hall has described a peculiar structure situated near the tail of the eel, which serves as an auxiliary to the heart, and performs a regular diastole and systole, quite distinct from that organ. Müller, aware of this discovery, examined the eel, and found, at the point of the tail, a pulsating organ containing a transparent reddish liquid, which was carried forward into a canal lying on the inferior side of the tail. On injecting the organ a number of large vessels were filled with the mercury on the same side on which the incision for introducing the injecting liquid was made. The soft fins were likewise reached by the mercury, and their rays presented the appearance of parallel canals. A principal canal 1½ line in diameter, corresponding with one on the upper side, lies on each side of the inferior surface, at the insertion of the fins, and between them are numerous small longitudinal vessels and transverse branches. Each of the vessels connected with these organs must be injected from their own side, either through the organs or by the longitudinal canals.

About the end of the gut the lateral canals on the under side appear to communicate on both sides with each other. The organ itself is obviously double, for pulsation is observed on one side while it has ceased on the other, in consequence of an incision.

Future experiments must determine whether or not the use of this organ is to propel the lymph of the tail into the extremity of the caudal vein.*

ON THE GLOBULES OF THE BLOOD.

The form of the globules of the blood has been differently stated by almost every observer. Müller, in employing an excellent microscope for the purpose of examination, found that they must not be viewed through the medium of water, because that liquid instantly alters their form, and converts elliptical globules into round ones. The best liquid to employ is serum, or the globules may be diluted with water holding in solution common salt, or sugar, which does not affect their shape. Müller attributes the various results of different observers to their diluting the blood with water, and to the employment of bad instruments. In man, the globules were found to be generally equal, with occasional larger ones. The globules of the frog were also equal, but mixed with some of a smaller size. In the embryo of the coney they are destitute of uniformity, but as the animal advances they become more equal. In the larva of the frog they appeared somewhat smaller and paler than in the mature state of the animal. The form of the globules varies in different animals, from circular to elliptical, but they are always flat. In men and mammalia they are circular; elliptical in birds, (domestic fowl and pigeon,) amphibious animals, (frog and lizards,) and fish, where they also approach a round form, especially in the carp. Müller has satisfied himself that the globules are flat, by a careful examination of the blood, not only of those animals mentioned, but also of the calf, cat, dog, and rabbit. The long diameter of the globules in men is four or five times greater than the broad diameter, and in the frog eight or ten times more extensive. Of the animals examined by Müller, they are smallest in men and mammalia, (among the latter the goat possesses the most minute globules, according to Prevost and Dumas, a fact which is confirmed by Müller,) a little smaller in the calf, largest in the naked amphibia, and inferior in size in birds, fish, and scaly amphibia. In man their broad diameter was found to be 0·000245—0·000373 English inch. The globules of the blood in birds are half as large as those of the frog, and of the latter animal the globules are many times larger than in man.

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* In addition to the two posterior lymphatic hearts of amphibia, Müller has lately discovered two anterior analogous organs, and has described them in the Phil. Trans. for 1833, part i. 92. They lie on each side, upon the great transverse process of the third vertebra, and are easily detected when the scapula is carefully raised and partly cut away. They are of a round shape, and pointed anteriorly where they are connected with the jugular vein on their respective sides. If these organs be incised and inflated, lymphatic spaces in the axilla become filled with air, and when injected upwards with mercury, the jugular vein as far as the superior vena cava, is filled.—Edit.

In the centre of the globules a spot may be detected, round or elliptical, according to their form, which by reflected light appears clear, and by transmitted light, dark. Dr. Young considered this a cavity. When the globules are held obliquely, so that part of one side is seen and part of the upper edge, a dark semi-circle is formed by the upper edge, the interior surface of which is convex and the other concave. According to Müller the globules of the blood in the frog and lizard contain a nucleus, which differs in chemical composition from the external substance surrounding it. The same nucleus he detected in fishes and birds, and in man he observed a very small round substance, yellower and brighter than the transparent matter which surrounded it. When the globules are placed in acetic acid under the microscope, the exterior coat is observed to be dissolved, leaving the nucleus in an isolated state, which in the human blood it is very difficult to see, but in the blood of the frog is very distinct. In the blood of the frog a smaller kind of globules occur, which are completely round, not flattened, and are much more minute than the elliptical globules.

Müller conceives that the nuclei of the elliptical globules may consist of the lymph and chyle globules, an opinion which seems to be strengthened by the circumstance that the chyle globules are completely insoluble in water, but that the globules of the blood are soluble as far as the nuclei, which are insoluble. As long as they are contained in the serum their colouring matter is insoluble, but when they come in contact with water the colouring matter is dissolved.

In blood extracted from men and cats, half an hour scarcely elapses before the globules sink 4 or 6 lines beneath the surface of the serum, while in that from oxen and sheep an interval of 12 or 24 hours occurs before the globules have subsided a line and a half.

If water, however, is added to blood extracted from mammalia, a portion of the colouring matter dissolves in that liquid, and a great proportion of the globules sinks to the bottom. In the blood of the frog the globules sink so rapidly that it is necessary to stir up the coagulum in order to have the globules mixed with the serum for the purposes of examination. When water is added to a mixture of serum and globules, and agitation employed, the colouring matter of the globules dissolves, and a light coloured precipitate falls to the bottom of the vessel, which appears under the microscope to consist of roundish globules, much smaller than those of the blood. This residue, from the action of water, is soluble in alkalies, but insoluble in acetic acid.

That the colouring matter of the globules is completely soluble in water, and is not suspended in that liquid, may be easily demonstrated, not only in human blood and in that of mammalia, but also more readily in the blood globules of the frog. Berzelius considers the insolubility of colouring matter in serum to depend on the presence of albumen. Müller, although he agrees in considering the colouring matter of the globules soluble in water, does not attribute the insolubility of the colouring matter in serum solely to the presence of albumen rendered soluble by soda, but more especially to the salts of the serum. When he placed under the microscope a drop of the blood of the frog, mixed with a drop of a solution of the yolk of an egg in water, he observed the blood globules change their form as rapidly as when he employed pure water. But when a drop of the same blood was joined with a solution of carbonate of potash or common salt, the form and size of the globules was not altered.

Water renders the globules smaller than the long diameter of the original ellipse, but larger than the broad diameter. But water containing carbonate of potash, or common salt, sal-ammoniac or sugar, in solution, produces not the slightest change in their shape and size. In a saturated solution, however, of carbonate of potash, they appear by degrees to become somewhat smaller.

When the globules have been treated with acetic acid the nuclei remain, varying in form in the blood of different animals. In the frog these nuclei appear not to be flat, or at least, not perceptibly so. In the salamander they are as distinctly flat as the globules themselves. The nuclei, when their external coat has been removed by acetic acid, have a brown colour, which appears to depend upon some colouring matter still adhering to them, for when treated with water they are white.

Hydro-chloric acid does not completely dissolve the outer coat of the globules, although it renders them sensibly smaller. *Chlorine* changes the colour of the blood of the frog, first causing it to assume a brownish hue, and then a whitish colour. *Tincture of nutgalls, liquor stibii muriatici, and liquor mercurii muriatici corrosivi* cause the globules to shrink.

A dilute solution of *muriate of iron* produces no change in the globules.

Caustic potash does not change their form, but speedily dissolves completely both external coat and nucleus.

Caustic ammonia dissolves them more rapidly, and when brought in contact with them makes them round.

Alcohol does not alter the globules.

Strichnin and Morphin are also inactive.*

The globules both in the arterial and veinous blood are of a similar shape and equal size, and Müller has not been able to detect any difference between the globules in the veins of the lungs of the frog and those of the body. He examined the effect of oxygen and carbonic acids upon the blood, in a tube over mercury. The former changed the blood of the frog to a brighter red, the latter made it very dark, and of a dirty violet colour.

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* Raspail states that hydro-chloric acid completely dissolves the globules. Ammonia and concentrated acetic acid have the same effect. Heat and alcohol coagulate them. If his observations are correct, although they are at variance with those of Müller, the globules must obviously consist of albumen. He affirms that blood may be simulated by the spontaneous evaporation of a menstruum containing albumen in solution and the addition of colouring matter. Nouveau Systeme de Chimie Organique, 8vo. 1833, p. 370.—Edit.

FIBRINE IN HEALTHY AND DISEASED BLOOD.

The usual explanation of the coagulation of the blood is that it is produced by the aggregation of the globules, and that the nuclei of the globules consist of bodies formed of fibrine, surrounded by a coat of colouring matter. Home, Prevost, and Dumas, have supported this view, and Dutrochet came to the same conclusion in his galvanic experiments.

Berzelius has conjectured, from the circumstance of the lymph containing fibrine in solution, that the blood also possesses fibrine dissolved in it, and that the lymph may be a fluid filtered from the blood.

Müller considers that he has established the truth of this conjecture, and has proved that the red coagulum is formed by a quantity of fibrine and globules of the blood, the fibrine being previously dissolved in the blood. For, when the blood of the frog is placed in a watch glass, before the formation of the whole coagulum, a clear thick matter may be extracted from the glass by means of a needle. If the serum be filtered through common white filtering paper, diluted with water, the globules are detained, and within a minute a colourless coagulum appears in the liquid, which passes through the filter so extremely transparent that its presence is scarcely detected till a needle is introduced for the purpose of raising it.

It gradually becomes whitish, and resembles the coagulum observed in human lymph. For the purpose of this experiment it is necessary to use paper which has been previously ascertained to allow the serum to pass without the globules, and pure blood must be employed, obtained directly, by incision, from the heart of the frog. When acetic acid is dropped into the filtered serum, the fibrine does not appear, but remains in solution. Caustic potash prevents the fibrine from collecting in a mass, but retains it in the form of small flocks, which are more distinctly seen when the liquid is dropped into a watch glass filled with sulphuric ether. The albumen of the serum is thrown down in a similar manner. Dilute caustic potash does not precipitate the albumen from the liquor of the blood, but concentrated potash readily effects its precipitation.

Caustic ammonia throws down albumen from the liquor of the blood, and also from the solution of the white of an egg. Caustic potash does not precipitate albumen from the egg, whereas the liquor of the blood will always be acted upon when small quantities of serum are added to large portions of caustic potash. In milk also the coagulable constituents are thrown down by a quantity of caustic potash, and the same circumstance occurs with regard to chyle, although milk is very different in its characters from chyle.

According to Tiedemann and Gmelin, and also Müller, the albumen of the egg is coagulated by ether, but that of the serum is not altered. The fibrine dissolved in the serum is easily distinguished from the albumen, in the same fluid, because the former coagulates of itself, while the albumen is only rendered solid by re-agents, by a particular temperature, and by the galvanic battery; and farther, according to Müller, ether coagulates the fibrine of fresh blood, but not the albumen.

Prevost and Dumas have endeavoured to estimate the quantity of the globules of the blood of different animals separately from red coagulum. Berzelius has observed, however, that these experiments cannot be very accurate; because the coagulum retains a quantity of serum, which, by drying, will be deficient in albumen and salts, while the washings will contain not only serum but also a portion of the red constituents of the blood.

Berzelius says that when blood is kept for several days, the red globules sink, and the serum sometimes becomes reddish, in consequence of a small portion of the colouring matter being dissolved. The experiments of Muller decidedly contradict this statement; for he has examined with two different powerful microscopes the blood of the calf, of oxen, of man, and the cat, and as long as water was prevented from coming in contact with the blood he could not observe the slightest alteration in the form and size of the globules.

In the blood drawn from man and cats the globules sank in 12 hours 5 or 6 lines below the surface of the serum.

The globules of the blood in the frog sink rapidly to the bottom of the vessel. Muller, in making some quantitative experiments on the blood of the ox, obtained from 3627 grs.

18 grs. of dry fibrine; and 39·45 grs. of the same blood yielded 6·41 grs. of dry red coagulum, which affords a per centage of 16·248 of dry red coagulum, the latter containing 0·496 fibrine.

(To be continued.)

ARTICLE IV.

Experiments and Observations on Visible Vibration.

By CHARLES TOMLINSON, Esq.

(Continued from p. 367.*)*

Note.—The following paragraph, which seems to have been passed over in copying, should have been inserted in the preceding paper at p. 363.

16. If two unisonant glasses containing mercury be employed, a faint impression of the undulæ can be observed in the second glass while vibrating the first. So also if the circumference of the mercury in the second glass be surrounded with shot, the vibration of the first glass will set the shot in motion. If the vibration of the first glass be suddenly interrupted by placing the hand upon it the second glass will continue to yield the same note, and the shot will vibrate for some seconds, in accordance as it were, with the fundamental note.

47. There is, perhaps, no music more sweet, or any that appeals more perfectly to the feelings than that produced by musical glasses. In the course of these experiments I had accumulated a great number of glasses, and it occurred to me that a set might be easily and cheaply arranged. Out of about thirty glasses that I had by me, I only met with five that answered my purpose: three soda water glasses, yielding the notes B flat, D and E within the stave, and two smaller ones yielding the notes G and A in alt. I accordingly sent for glasses at different times, to the amount of about a hundred, or a hundred and fifty. I ranged about a dozen at a time on a smooth mahogany table, and sounded the notes required on a flute, resting the end on the table, so that any of the glasses in accordance with the note sounded sympathetically; if none accorded all were silent. By this means I became not only sure of a perfect instrument, but

spared myself the trouble, and what to me was of most consequence, the time of testing each glass separately. This method also is superior to that depending on a musical ear, however good it may be. Thus, I completed two octaves, together with four of the most useful semi-tones, and arranged them in a deal case according to Dr. Arnott's method, which is a very convenient one. My instrument allows me to play upwards of fifty popular tunes and national airs in the key of B flat major; and, in point of tone it surpasses those sold by the makers, who charge from twelve to fifteen guineas for two octaves, while mine has cost me but twenty-five shillings.

48. Dr. Franklin, I believe, contrived the first instrument and suggested the method of tuning the glasses by means of water. But this mode is objectionable for several reasons. The effect of water is to lessen the number of vibrations, and thus to lower the fundamental note of the glass. By this means, not only is the natural richness of the note impaired, but the relative accuracy of the notes can rarely be obtained. In warm weather I have known an instrument get out of tune in a few hours simply by the evaporation of the water. A patent was, I think, taken out some years ago to remedy this defect. The patentee dispensed altogether with water, and coated the belly of the glass with a cement which dried and hardened, and thus brought the note down to the desired pitch. This mode, it will be seen, is objectionable, as the tone is much deteriorated, and should any of the cement chip off, which it is not unlikely to do in using or cleaning, the note becomes immediately wrong. Another method is to grind the glasses to the proper pitch, this, however, is both tedious and expensive, and, therefore, objectionable.

49. By the plan that I propose, (47.) all these objections are obviated, and a beautiful instrument is obtained, possessing the great advantage, so well appreciated by the musical amateur, of being always in tune. It will, however sometimes happen that a glass may be met with yielding a full sympathetic note, yet when vibrated by the finger the interference of sound (12.) arising from irregularities unappreciable to the eye, will be sufficient to exclude it from the set, but this objection is easily obviated, by having recourse to another glass.

50. It is important and interesting to investigate the changes undergone by a glass during vibration, in order to obtain more information as to the multiform variety of vibration in various bodies. I have obtained many curious results, which I will detail hereafter. In the present paper, I propose to state the effect of various fluids in modifying or changing the note produced by the vibration of a foot glass.

51. It does not appear that performers on musical glasses tuned by means of water have been aware *that a fluid may be added to a glass to a certain height without perceptibly altering the note, or its capability of yielding sympathetically the fundamental note, and that the quantity of fluid necessary to modify or change the fundamental note depends upon its specific gravity.* Thus, for example, if a cylindrical foot glass be taken, the fundamental note of which is the first C in alt, and that note be sounded on a flute within one or two feet, the glass will vibrate the same note though it contain water to the depth of $1\frac{3}{10}$ of an inch, and under. If, however, that limit be passed, the fundamental note begins to descend.

52. The glass that I employed as a standard in the following experiments was $3\,\frac{1}{20}$ inches in height, omitting the foot. I graduated it on the exterior side to twentieths of an inch, and, in stating my results, I shall, for the sake of convenience, adhere to the vicesimal division of the inch.

53. By this it will be seen that *there is a line passing round the glass latitudinally, which line I propose to call the axis of vibration*, a point on which the fundamental note of the glass seems to turn. There are other lines which I have succeeded in tracing which will be described hereafter; my present purpose is with this one particular line.

54. This line is probably fixed and invariable in the same glass, but it appears to rise and fall in proportion to the specific levity and gravity of the fluids employed. It is, I believe, confined to the interior of the glass, for I incline to think that active or positive vibration is confined to the interior of a glass, the exterior being negative.* The

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* This, together with other changes undergone by a glass during vibration, will form the subject of the next paper, wherein, the producing cause of the currents of mercury, and their action, will also be further considered.

action of a fluid of great specific gravity in a glass is to neutralize the parts of the glass in contact with that fluid. Mercury does so very perfectly, water in a manner less perfect, and ether still less perfect, and so on.

55. The following results were obtained when distilled water at 60° was employed :—

Axis $1\frac{6}{20}$ *inch.*

$1\frac{8}{20}$	inch —	B
$1\frac{16}{20}$	,,	B flat.
$2\frac{2}{20}$	,,	A
$2\frac{7}{20}$	,,	G sharp.
$2\frac{11}{20}$	,,	G
$2\frac{15}{20}$	,,	F sharp.
$2\frac{18}{20}$	,,	F
3	,,	E glass full within $\frac{1}{20}$ inch.

56. Pure mercury was next employed with the following results :—

Axis $\frac{13}{20}$ *inch.*

$\frac{16}{20}$	inch	B
1	,,	B flat.
$1\frac{3}{20}$	,,	A
$1\frac{4}{20}$	,,	G sharp.
$1\frac{7}{20}$	,,	G
$1\frac{8}{20}$	,,	F sharp.
$1\frac{10}{20}$	,,	F
$1\frac{11}{20}$	,,	E
$1\frac{12}{20}$	,,	D sharp.
$1\frac{14}{20}$	,,	D
$1\frac{15}{20}$	,,	C sharp.
$1\frac{17}{20}$	inch	C
$1\frac{18}{20}$	,,	B
2	,,	B flat.
$2\frac{1}{20}$	,,	A
$2\frac{3}{20}$	,,	G sharp.
$2\frac{4}{20}$	,,	G
$2\frac{6}{20}$	,,	F sharp.
$2\frac{8}{20}$	,,	F
$2\frac{10}{20}$	,,	E
$2\frac{11}{20}$	,,	*D sharp.
$2\frac{12}{20}$	,,	*D
$2\frac{14}{20}$	inch	*C sharp.
$2\frac{16}{20}$	,,	C the lowest note on the flute.
$2\frac{17}{20}$	,,	B tried by the octave above.

(Those notes marked with a star were produced by striking the glass with a wooden hammer covered with leather.)

57. The large number of notes obtained from the glass when mercury was employed surprised me. I have before stated (21.) that a fluid in a glass raises, as it were, the bottom of that vessel. This remark, however, is not strictly true, but the effect is best obtained when so heavy a fluid as mercury is employed. The vibrations being neutralized from the surface of the fluid downwards; whereas, with the

other fluids, the neutralization only *decreases* from the surface of the fluid downwards; so that, in order to obtain the same number of notes from water as from mercury, it would be necessary to employ a glass about three times as high.

58. Before I proceed further it may be necessary to state my method of conducting these experiments. The same graduated glass (51.) was employed throughout, fixed on a level plane, and the results, generally speaking, not taken until the glass yielded the descending notes sympathetically responsive to a flute. The glass was carefully washed, and wiped dry at the end of each experiment, and the specific gravity of each fluid was taken immediately before it was employed. I have gone twice over these and the two previous (55, 56.) experiments. In the first trial my pupil, Mr. Whitchurch, sounded the flute, and in the second, Mr. Aylward, a professor of that instrument, a gentleman on whose correct musical ear I can implicitly rely.

59. The following liquids were successively employed in the order of their specific gravities, as follows:—

	Sp. Gr.
1. Sulphuric acid	1·852
2. Nitric acid	1·351
3. Muriatic acid	1·139
4. Pyroligneous acid	1·044
5. Castor oil	0·957
6. Linseed oil	0·933
7. Oil of turpentine	0·871
8. Pyroligneous ether	0·856
9. Oil of olives	0·810

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1. SULPHURIC ACID.

Axis $1\frac{2}{20}$ *inch.*

$1\frac{7}{20}$	inch	B	$2\frac{10}{20}$	inch	F
$1\frac{13}{20}$	,,	B flat.	$2\frac{13}{20}$	,,	E
$1\frac{18}{20}$	,,	A	$2\frac{16}{20}$	,,	D sharp.
$2\frac{1}{20}$	,,	G sharp	$2\frac{18}{20}$	,,	D
$2\frac{4}{20}$	,,	G	$3\frac{1}{20}$	,,	C sharp.
$2\frac{8}{20}$	,,	F sharp.			

2. NITRIC ACID.

Axis $1\frac{2}{20}$ *inch.*

$1\frac{11}{20}$	inch	B	$2\frac{12}{20}$	inch	F sharp.
$1\frac{18}{20}$	,,	B flat	$2\frac{15}{20}$	,,	F
$2\frac{2}{20}$	,,	A	$2\frac{17}{20}$	,,	E
$2\frac{6}{20}$	,,	G sharp.	3	,,	D sharp.
$2\frac{9}{20}$	,,	G			

3. MURIATIC ACID.

Axis $1\frac{7}{20}$ *inch.*

$1\frac{12}{20}$	inch	B	$2\frac{11}{20}$	inch	G
$1\frac{19}{20}$	,,	B flat.	$2\frac{13}{20}$	,,	F sharp.
$2\frac{3}{20}$	,,	A	$2\frac{16}{20}$	,,	F
$2\frac{8}{20}$	,,	G sharp.	$2\frac{19}{20}$	,,	E

4. PYROLIGNEOUS ACID.

Axis $1\frac{7}{20}$ *inch.*

$1\frac{12}{20}$	inch	B	$2\frac{13}{20}$	inch	G
2	,,	B flat.	$2\frac{16}{20}$	,,	F sharp.
$2\frac{4}{20}$	,,	A	$2\frac{19}{20}$	,,	F
$2\frac{8}{20}$	,,	G sharp.	$3\frac{1}{20}$	,,	E

5. CASTOR OIL.

Axis $\frac{18}{20}$ *inch.*

$1\frac{7}{20}$	inch	B	$2\frac{12}{20}$	inch	G
$1\frac{17}{20}$	,,	B flat	$2\frac{15}{20}$	,,	F sharp.
$2\frac{3}{20}$	,,	A	$2\frac{19}{20}$	,,	F
$2\frac{8}{20}$	,,	G sharp.			

6. LINSEED OIL.

Axis $1\frac{9}{20}$ *inch.*

$1\frac{12}{20}$	inch	B	$2\frac{14}{20}$	inch	G
$1\frac{18}{20}$	,,	B flat.	$2\frac{17}{20}$	,,	F sharp.
$2\frac{4}{20}$	,,	A	3	,,	F
$2\frac{10}{20}$	,,	G sharp.			

7. OIL OF TURPENTINE.

Axis $1\frac{3}{20}$ *inch.*

$1\frac{14}{20}$	inch	B	$2\frac{14}{20}$	inch	G
$1\frac{19}{20}$	,,	B flat.	$2\frac{18}{20}$	,,	F sharp.
$2\frac{6}{20}$	,,	A	3	,,	F
$2\frac{10}{20}$	,,	G sharp.			

8. PYROLIGNEOUS ETHER.

Axis $1\frac{3}{20}$ *inch.*

$1\frac{15}{20}$	inch	B	$2\frac{11}{20}$	inch	G sharp.
$2\frac{3}{20}$	,,	B flat.	$2\frac{15}{20}$	,,	G
$2\frac{7}{20}$	,,	A	$2\frac{18}{20}$	,,	F sharp.

9. OIL OF OLIVES.

Axis $1\frac{5}{20}$ *inch.*

$1\frac{15}{20}$	inch	B	$2\frac{12}{20}$	inch	G sharp.
$2\frac{1}{20}$	,,	B flat.	$2\frac{15}{20}$	,,	G
$2\frac{6}{20}$	,,	A	$2\frac{19}{20}$	,,	F sharp.

Brown Street, Salisbury,
28*th April* 1835.

ARTICLE V.

On the accidental Colours of certain solutions on Mercury.

By CHARLES TOMLINSON, Esq.

To the Editor of the RECORDS OF GENERAL SCIENCE.

DEAR SIR,

IN the course of my experiments on Visible Vibration, I noticed a ready and convenient method of observing accidental colours without fatiguing the eye, which was new to me, and will, I hope, prove interesting to some of the readers of your Journal.

Having occasion to diminish somewhat the reflecting surface of mercury contained in a foot glass, I poured about an ounce of a solution of litmus, which had become slightly reddened by exposure to the air, upon the surface of the mercury, when the upper portion of the glass above the fluid was reflected twice, the lower reflection by the mercury and the upper one by the litmus solution. On placing the finger on the periphery of the glass, and bringing one eye near to another part of the periphery, two reflections of the finger were seen; one the colour of the litmus, a beautiful purple inclining to red, and the other a delicate light green its accidental colour.

On adding a few drops of nitric acid to the litmus solution, the accidental colour was of a dark and decided green.

With mercury and a solution of chromate of potash a fine blue accidental colour was obtained.

With muriate of lime the same result was obtained with this addition; on looking steadfastly into the glass with one eye, the other being closed, a variety of white spots began to form on the iris, giving the eye an unpleasant mouldy sort of appearance. The aqueous humour seemed to consist of one isolated drop of water, so distinct from any other part of the eye, that it seemed as if it would have dropped down into the glass; in a short time the transparent membrane covering the pupil became milky, and the glass and fluids indistinct. I have repeated this experiment with the same results, except that the white spots on the iris were not so numerous.

With a deep blue solution on mercury obtained by indigo in sulphuric acid, the accidental orange-yellow was obtained.

These accidental colours are neither modified nor changed by the reflection of various coloured solids, such as blue, yellow and green balls, &c., the accidental colour belonging to the upper fluid and not to the object reflected. In order to obtain them, however, two liquids of different densities must be employed in order to obtain two reflections, and for the lower fluid nothing is so convenient as mercury. Indeed, I have not as yet met with any other fluid that at all answers the purpose.

The effect is very beautiful with litmus solution and mercury when the flame of a candle is employed; the two reflections have the appearance of hollow cones placed above and within each other, the lower flame being the accident.

With muriate of lime the lower flame reflected by the mercury was of a decided yellow, but the accidental colour of a very faint blue; whereas, by natural light the accidental is of a fine indigo.

The green flame obtained by boracic acid in alcohol presents a very fine appearance with litmus and mercury. A watch glass should be employed supported on a ring formed out of a piece of wire, and other lights in the room extinguished.

Yours, Dear Sir,
very sincerely,
CHARLES TOMLINSON.

Brown Street, Salisbury,
April 22, 1835.

ARTICLE VI.

On Malt. By ROBERT D. THOMSON, M.D.

AT a time when so much excitement exists in regard to the subject of Malt, it will not, perhaps, be considered a superfluous undertaking if I attempt to lay before my readers an outline of the process to which grain is subjected before it acquires this designation.

A knowledge of the peculiarities of this interesting process is important in a double point of view, because it affords a remarkably beautiful specimen of the chemistry of nature, and because its product forms a staple commodity of British manufacture, no less than forty millions of bushels of malt being annually consumed in the United Kingdom, which, at 60*s.* per quarter, exceeds in value the large sum of £24,000,000, and contributes a revenue to Government at 2*s.* 7*d.* per bushel of more than £5,000,000 per annum.

It would throw no light upon the chemical nature of malting if we were to endeavour to investigate the history of its discovery, because the changes which grain undergoes during the stages of the process, are not yet fully developed; and we are, therefore, led to infer that the introduction of this preparatory step to fermentation was the consequence of some accidental observation.

It is sufficiently well known indeed that the method of inducing the vinous fermentation was understood at a very early period. Thus the Chinese distil *samshoo*, an ardent spirit, (and we are sure that any practice which exists among them is of very high antiquity) from rice and the roots of plants, and the savages of the Pacific Ocean prepare a similar product from the masticated roots of herbs.

The Abyssinians have long been in the habit of fermenting the husks and stones of grapes, and distilling the brandy which is highly concentrated through a hollow cane called *shambacco*.* And the Germans, at the earliest period to which their history carries us, were so partial to fermented liquor, that they believed if they obtained the favour of their divinity (Woden) by their valour, they should be admitted after their death into his hall, and reclining on couches, should regale themselves with beer from the skulls of their enemies whom they had slain in battle.*

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* Pearce's Travels, i. 237.

But for these objects malting is not necessary, for even in this country much spirit is made from raw grain. The quantity of grain consumed in this way amounted, in 1834, to 6,694,344 bushels.

We may consider the subject, first in reference to its physical nature, or the process of malting, and secondly in an economical point of view, or the duty on malt.†

I. PROCESS OF MALTING.

Any kind of grain may be converted into malt, but in this country there are three species of plants belonging to the order *Cereales* which are peculiarly employed for this purpose. These are Hordeum *distichum*, H. *vulgare*, and H. *hexastichon*.

1. The H. *distichum* is what is commonly termed *barley*,‡ and is characterized by having two lateral rows of seeds which are imbricate. The average length of a seed is 0·343 inches. Breadth 0·143 inch. Thickness 0·108 inch.

2. H. *vulgare* Linn. in herb. Errh. Pl. Off. 421. Herb. Davall. 1802, described by Linneus as having two rows of seeds more distinct, but there are two additional imperfect ones. The length of a spike of average grain is 3 inches. Length of a seed ·375 inch. Breadth 0·16 inch.

It is to this species that the name *bigg*, I believe, is more peculiarly applicable. The term is one employed by the country people in Scotland, who are not in general, as elsewhere, very precise in their definitions, and are apt to apply one term to different species. Indeed, the whole of the species are often indiscriminately called *bear*, a mixture being often sown which is termed *blended bear*.

3. H. *hexastichon*, Linn. Spec. Plant. 125. Hort. Ups. 23. This species is described by Linneus as possessing universally hermaphrodite flowers, with the seeds placed regularly in six rows. The seeds in my specimen were in length ·325 inch, in breadth ·15 inch, and much inflated and rounded

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* Hume's History of England, i. 31.

† See Papers presented to the House of Commons in 1799, 1804 and 1806.

‡ Through the kindness of my friend Mr. Don, I have had an opportunity of identifying this and the following species with the specimens in the Linnean herbarium.

on the external surface. Length of the spike 1·7 inch. I have been favoured with the authority of an extensive farmer for identifying this species with the Scotch *bear*. "*Bigg*," says he, "has four rows on the head, two of which are better than the others and contain also more grains. *Bear* has six rows, is a strong coarse grain and may be easily known after separation from the straw, by its thick husk and long awn." The first of these distinctions may be a tolerable criterion, but the latter is decidedly not so, because in Irish specimens which I possess, the awns of the H. *vulgare* are much longer than those of the H. *hexastichon*. It is, therefore, a matter of great doubt whether in all cases these species of grain can be distinguished after separation from the straw.

The correct discrimination of these species is of great importance, because the quality of the malt is inferior in the two latter. From the experiments made in 1806 by order of Government, it appears that the value of barley is to bigg as 100 to 89½, taking the mean of the value of English and Scotch barley as the standard; but if we consider the Scotch barley still as of inferior quality to the English, then the relations will be as in 1806, English barley 100, Scotch barley 93, Bigg 86; or the malt of *bigg* is 14 per cent. inferior to that of English barley, and 7 per cent. inferior to that of Scotch barley. Their relative values may, perhaps, be better appreciated by attention to the product of spirit derived from each. Thus the quantity of proof spirits per quarter of each, is exhibited in the following table:

	Wine measure.	Imperial measure.
English Barley .	20·76 gallons.	17·20 gallons.
Scotch Barley .	20·02 ,,	16·70 ,,
Scotch Bigg . .	18·96 ,,	15·72 ,,

They differ also in respect of weight, so that the quality may be in some measure detected by this test. The average weight of each kind of grain is represented as follows:

	lbs. avoird.		Imperial measure.
English Barley	49·871	per Winchester bushel.	51·444
Scotch Barley	49·754	,,	51·327
Scotch Bigg.	47·352	,,	48·849

From experiments, it appears that the grain does not lose any weight by keeping. After an interval of six months, the difference of weight scarcely ever amounted to $\frac{1}{100}$th, and this was generally in favour of the grain which had been kept longest.

If we inquire into the natural history of these different species, we shall be able to throw some light upon the causes of the difference in the value of their grain.

Bigg and *bear* are susceptible of exposure to greater vicissitudes of climate than barley is. They require also less time to attain to maturity. Thus, the average time in which they usually remain in the ground is from ten to fourteen weeks; while barley lies from fourteen to twenty weeks. An instance is recorded where the interval between seed time and harvest, in the case of *bear*, was only nine weeks; and another, on the contrary, where barley was twenty-six weeks of ripening. Bear and bigg in common years are malted by the Highlanders, but in those seasons which are unpropitious for the ripening of oats, they form the chief article of food. Hence, the legislature have been induced to charge a duty of 2s. 7d. per bushel on malted barley, and 2s. only on malted bear and bigg. In 1789 and 1799, which were late years, the whole of the barley sown in Aberdeenshire was destroyed, a circumstance which operated so powerfully upon the farmers, that in 1803, little more than 100 quarters were raised, while from 35,000 to 50,000 quarters of bear and bigg were produced.

Now, Aberdeenshire consists of 832,000 English acres and possesses a mean temperature of 41°·14.

Mr. Forbes Royle observed barley growing on the Himalah mountains, at an elevation of 8000 feet, the mean temperature of the place being 55° F. But some very important deductions have been obtained by M. M. Edwards and Colin,* from their interesting experiments upon the germination of different kinds of grain. They exposed barley, wheat and rye to a cold equal to that at which mercury freezes or—38·6° F. for 15 minutes, and found that their vegetative powers were not in the least deteriorated. They ascertained that if barley, wheat, French beans or linseed were immersed for a quarter of an hour in water at the temperature of 154°, the power of germination was completely destroyed, and it was not till the heat of the water was reduced to 122°, that these kinds of grain after being immersed in it would vegetate. Hence, in water, 122° may be considered the highest limit at which it is possible for barley to grow. But the temperature varies according to the media through which the heat is communicated. Thus these seeds if exposed to a temperature above 143½° in vapour, or 167° in dry air, are deprived of their vegetating properties. While wheat, barley, oats and rye, when kept in hot sand possessing a heat of 113°, would not germinate. Immersion in water of the temperature of 167° for 15 seconds was sufficient to destroy the power of germination in most instances; but this invariably occurred, if the exposure to this high temperature was protracted for 5 minutes. The method in which the heat operates in these cases, appears to be in some measure elucidated by the researches of Biot, Persoz, and Raspail, who observed that the temperature 167° is that at which the grains of starch burst. Hence, it appears, that in dry air barley may be exposed to a range of temperature equivalent to 205° at least, and may still retain its germinating powers unimpaired.

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* Ann de Scien. Nat. for May, 1834.

We have two quantitative analyses of barley, one by Einhof and the other by Proust. The following are their results. Einhof obtained from Hordeum *vulgare.*

Starch not quite free from gluten . .	67·187
Volatile matter	9·375
Saccharine matter	5·208
Husk with some gluten and starch . .	6·770
Mucilage	4·583
Gluten	3·515
Albumen	1·114
Phosphate of lime and loss	2·248
	100·000*

Proust obtained,

Yellow resin . . .	1·
Gum	4·
Sugar	5·
Gluten	3
Starch	32·
Hordein	55·
	100·†

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* Gehlen, vi. 83. Thomson's Chemistry, iv. 262.

† Ann. of Phil. xii. 201.

In these results we observe considerable differences, which are to be attributed to the mode in which the analyses were conducted.

Einhof determined the weight of the starch and gluten together, when they had been deposited from water in which the meal contained in a linen bag had been kneaded.

The water from which the starch was separated was filtered and boiled; coagulated albumen subsided, and by evaporation an extract was afforded which was treated with alcohol. It gave gluten and sugar. These substances were separated by mixing the alcoholic solution with water and distilling the alcohol. The gluten fell down, and the sugar remained dissolved in the fluid. The alcohol left undissolved some gum and phosphate of lime. The former was taken up by water and left the latter in a pure state. The matter in the linen bag consisted of vegetable fibre, mixed with a little gluten and starch. The *hordein* of Proust was obtained equally well by means of hot or cold water, which dissolved the starch and left the *hordein* in an insulated state. Raspail considers this substance to be the pericarp of the seed or what we term bran. The propriety of this opinion is strengthened by the circumstance that there is very little of it existing in pearl barley. The substances reckoned by the French chemists as constituents of starch, viz. *amidone*, *diatase*, *amidine* and *dextrine*, there is strong reason to consider as products of the analytical operations.*

It is a remarkable circumstance, in reference to the starch which forms such a principal constituent of the seed of barley, that it is possessed of a most durable nature when preserved in dry magazines. This fact is illustrated in a very striking point of view by some researches of the French chemists.† In 1817 a depôt of barley was discovered in the citadel of Metz, which had remained closed up from the year 1523, and notwithstanding that it had remained in this state for 294 years, it afforded excellent bread when converted into meal. A similar magazine was also recently detected in some villages destroyed by the Turks in 1526, where the corn appeared to have lost none of its qualities proper for forming an essential article of food.

These, though remarkable instances of the capacity which the starch of barley possesses of withstanding decomposition, must yield infinitely in importance to observations which have been made upon grain preserved in the collections of M. Passalacqua. That gentleman brought from the ruins of Thebes, in Egypt, some grain, which, when examined by D'Arcet, Vauquelin, Bailly, and Fontenelle, was found to be slightly acid, and to contain its proper quantity of starch, but no gluten. Raspail subsequently confirmed the accuracy of these chemists. When Passalacqua sold his collection of antiquitiès to the king of Prussia, Champollion found between the limbs of a mummy (which he recognised as the remains of Pharoah, son of Marsaroun Mainoute, or priest of a great tribe attached to the worship of the goddess Netpha, the Egyptian Rhea mother of Osiris and Isis,) a small brown compact loaf, surrounding a number of grains of barley, which had germinated and been slightly scorched. These seeds, which must have been above 3000 years old, were examined by M. Julia Fontenelle, who could detect no gluten in them, but found that the starch, by its action on iodine, was not impaired in its properties. A little acid was also present, as was demonstrated by the re-action on test-paper.

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* Records of General Science, i. 196.

† Journ. de Chim. medicale, i. 63, 2nd. ser.

When exposed to the air and moisture, however, starch undergoes a remarkable change. M. Lassaigne examined some wheat which was found in pulling down a house in Paris, at the Quai de la Greve. It possessed a black colour, as if it had been converted into charcoal. It contained neither starch nor gluten, but much *ulmine or ulmic acid.* The appearance of the grain led this chemist to believe that it had been partially converted into coal, in a manner similar to that in which trees and smaller vegetables have been changed into coal, jet, and peat. Wheat found at Royat, near Clermont, (Auvergne) in the mountain called the Granaries of Cæsar, M. Lassaigne ascertained had undergone a similar change.

The precise researches of Raspail enable us to comprehend in some measure the cause of this stability in the nature of starch. According to him, starch consists of grains which vary in form and dimensions, the diameters not exceeding, in maturity, ·00393 inch; but before they have attained their full size, being exceedingly more minute. Those of the Hordium *vulgare* are about ·0098 inch in diameter. In each grain, when viewed under the microscope, the rays of light are strongly deviated at their entry and departure, so that only those reach the eye which pass through the interior of the globule, and hence, they appear as black balls with a white nucleus. They consist of vesicles, filled with a gummy matter, which hardens in contact with air. In water of the temperature 122° the bladder is expanded, probably by the increase in volume of the gum. In boiling water it is ruptured and precipitated, while the gum (the *dextrine* of Biot) dissolves in the water. Iodine colours the grains, not by combining with them, but by merely attaching itself to the exterior of the visicles. The form of the grain is not altered; for, if inorganic salts capable of combining with the iodine, and forming hydriodates, are mixed with the starch, the colour disappears, and the starch remains colourless.*

The nature of the *diatase* which Payen and Persoz have found in starch, Raspail explains in this way: In the act of germination the grains of which starch consists increase by successive layers, beginning nearest the cotyledon, while at the same time acetic acid is formed; now this acid dissolves gluten, and renders it equally soluble in water and alcohol. If the flour of germinating barley be macerated for an hour in pure water, the water will dissolve the gum, sugar, and gluten combined with the acetic acid. When exposed to heat a flocky precipitate will be produced by the disengagement of a portion of the acetic acid by heat, or of its saturation by some base, disengaged from the tissue by the temperature. Alcohol will increase the quantity of the precipitate. Raspail digested for a few minutes some wheat flour in acetic acid, at first concentrated, and then diluted with a hundred times its weight in water. It was filtered, and the liquid poured into a solution of starch. A precipitation of the tegumentary matter immediately ensued.

These facts are extremely important when considered in connexion with the process of malting, because they exhibit in a powerful manner the greatness of the change which is produced by the slightest effort of Nature's operations, and because they enable us to comprehend more readily the variety of alterations which the elements of grain undergo in the same process.

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* Nouveau Systeme de Chimie organique fondé sur des methodes nouvelles d'observation par F. V. Raspail, 8vo. 1833, p. 3, 562.

The process of malting consists essentially, 1*st*., in producing a change in the constituents of grain by inducing germination; and 2*nd*. in stopping the vegetation when it has been carried to a certain extent, by exposure to heat.

(To be continued.)

ARTICLE VII.

Analysis of Wolfram. By Mr. THOMAS RICHARDSON.

IN 1781 Scheele discovered a peculiar substance in a heavy white mineral found in Sweden, to which he gave the name of *Tungstic acid*, the base being called *Tungsten* from its weight. Shortly after this Messrs. D'Elhuyart obtained the same acid in a mineral called by the Germans wolfram, which had been analyzed in 1761 by Lehmann, who considered it to be a compound of iron and tin. Weigleb and Klaproth also analyzed this mineral, but nothing can with any confidence be drawn from their results, both of them having a deficiency of upwards of 21 per cent. Vauquelin repeated the experiments of the Elhuyarts in 1796, and obtained the following:

Tungstic acid	67·00
Protoxide of manganese . .	6 25
Protoxide of iron	18·00
Silica	1·50
	92·75

Part of the iron Vauquelin supposes to be in the state of peroxide. But even if this supposition were adopted there would still be too great a deficiency to warrant us in drawing any conclusion from the analysis. Berzelius published a set of experiments upon tungsten in 1815, and states the composition of this mineral to be, according to his analysis:

Tungstic acid	74·666
Protoxide of manganese . .	5·640
Protoxide of iron	17·954
Silica	2·100
	100·000

The quantity of tungstic acid was determined from the loss, which prevents us from placing so much confidence in it as we could otherwise have done, from the known dexterity and precision of the analyst.

This mineral occurs generally along with tinstone, in veins and beds; it is met with also traversing greywacké, with ores of lead, &c. It is found in almost all the Saxon and Bohemian tin mines, as also in several places in Cornwall.

It is thus found in France: In Siberia it occurs accompanying the emerald, and also in the United States of North America.

It occurs massive, and often crystallized. The primary form being a right oblique angled prism. The specimen subjected to analysis was from Zinnwald, in Bohemia, and seemed perfectly pure.

It possessed the following characters:—

Foliated; not very brittle; fracture uneven; streak, reddish brown; colour, blueish black; lustre, approaching metallic; opaque; hardness, 5·0 to 5·5; sp. gr. 7·017.

Before the blowpipe, decrepitates when heated alone, but may be melted in a high temperature into a globule, possessing the metallic lustre.

With soda, on platinum wire, it fuses into an opaque green coloured bead in the oxydizing flame, which changes to pink in the reducing flame: with borax fuses easily into a transparent red coloured bead in the oxydizing flame, which becomes pale yellow in the reducing flame. With salt of phosphorus fuses readily into a transparent yellow coloured bead in the oxydizing flame, which becomes red in the reducing flame. On adding a small piece of tin to this red coloured bead and continuing the flame for a short time the colour changed to green.

It was analyzed in the following way:—

A. 20. grs. of the mineral, in fine powder, were kept fused with 60 grs. of carbonate of soda (anhydrous) for half an hour. The whole, upon cooling, was digested in water for 48 hours. The insoluble portion which remained behind was separated by a filter, and well washed with distilled water. The solution which came through the filter, together with the washings, being evaporated to a convenient bulk, pure nitric acid was added, and the tungstic acid precipitated of a beautiful yellow colour. After being well washed with distilled water, acidulated with nitric acid, dried and ignited, it weighed 14·39 grs., or 71·95 per cent.

B. The undissolved portion which remained on the filter in (A.) was dissolved off by muriatic acid, and the solution neutralized as exactly as possible with carbonate of ammonia. The whole was now boiled with benzoate of ammonia in a flask on the sand-bath, and the benzoate of iron which it precipitated was separated by a filter. After being clean washed, dried and ignited, the peroxide of iron which remained weighed 2·58 grs. = 2·362 grs. protoxide of iron.

C. The solution and washings from (B.) being evaporated to dryness, the whole was exposed to a red heat, to get rid of the ammoniacal salts. What remained was dissolved in water, and boiled with carbonate of soda. The manganese which precipitated was separated by a filter, and after being well washed, dried, and ignited, weighed 3·37 grs. red oxide = 3·137 protoxide of manganese.

Hence, we have for the composition as follows:—

Tungstic acid	14·390	or	71·950
Protoxide of iron	2·362	,,	11·810
Protoxide of manganese . .	3·137	,,	15·685
	19·889		99·445

The difference between this and the preceding analysis of Berzelius induced me to make another, and the result of the second, executed in the same way, gave as follows:—

Tungstic acid	73·60
Protoxide of iron	11·20
Protoxide of manganese . .	15·75
	100·55

Agreeing with the first very nearly except in the quantity of tungstic acid.

If we adopt Dr. Thomson's atomic weight of tungstic acid, as given in the last Edition of his System of Chemistry, and calculate, we obtain the following:—

	atoms.		
Tungstic acid	4.74	or	1·90
Protoxide of iron	2·49	,,	1·00
Protoxide of manganese . .	3·50	,,	1·40

Which approaches very nearly the following formula:

$$f^2\,\dot{T}n. + 1\tfrac{1}{2}\,mn.\,\dot{T}n.$$

But, if we deduce the atomic weight of Tungstic acid from the last analysis, we have,

26·95 *(the whole bases)* : 4·5 *(an atom of bases)* : :
73·60 *(the whole acid)* : 12·28 *(an atom of acid)*

Approaching 12·25 as nearly as can be expected from the inaccuracies incidental upon experiments. Employing 12·25 then, as the atom of tungstic acid, and calculating as before, we get

	atoms.				
Tungstic acid	6·00	or	2·41	nearly	$2\frac{1}{2}$
Protoxide of iron . .	2·49	,,	1·00	,,	1
Protoxide of manganese	3·50	,,	1·40	,,	$1\frac{1}{2}$

represented by the formula, $f\,\dot{T}n. + 1\frac{1}{2}\,mn.\,\dot{T}n.$

The difference between this and former analyses would lead to the opinion that they were different species, since both that of Berzelius and the present one agree exceedingly well, with the atomic proportions deduced from the formulæ by which they are represented.

Great doubt still hangs about the atomic weight of tungstic acid, and further experiments are required to elucidate the subject.

ARTICLE VIII.

Erysipelas of the Extremities Successfully Treated by Mechanical Pressure. By JAMES ALLAN, Esq. SURGEON.

DEAR SIR,

SHOULD you deem the following cases illustrative of a new and effectual method of treating Erysipelas of the extremities worthy of a place in your valuable Journal, you will oblige me by inserting them,

Dear Sir, yours truly,

10, *Cannon Street*, 8*th March* 1835. JAMES ALLAN.
To Dr. R. D. Thomson.

Case 1*st*., *April* 5, 1823.—Mrs. H. aged 40, of a sanguine temperament and plethoric habit, complains of considerable pain and heat affecting the whole of the back of the right hand, extending about three inches above the wrist, which is much swelled and reddened, pits on pressure, and presents every appearance of phlegmonous erysipelas. Became affected with a rigor and headache yesterday forenoon, shortly after which the back of the hand became painful and swollen. Pulse 100 firm; tongue white; bowels confined; appetite bad; skin dry.

The hand, wrist, and forearm, the two first particularly, were tightly bandaged and supported in a sling. She was directed to take *Magnes. sulph.* half an ounce, with the same quantity of *Infus. sennæ* every four hours, till the bowels were freely acted on, and requested not to remove the bandage till I should see her again.

Ten hours after. Has scarcely felt any pain these last eight hours; bandage removed; swelling and redness nearly gone; bowels have acted freely from two doses of the mixture. Bandage applied as before, but rather tighter, and the arm supported in a sling; the mixture to be discontinued.

— *6th.* Has passed a comfortable night, having felt only slight pain occasionally. Redness has entirely disappeared; swelling scarcely perceptible; pulse 80; tongue white and moist; skin moist. Bandage re-applied, and a mixture similar to that ordered before to be taken every four hours till the bowels become relaxed.

— *7th.* Pain and swelling entirely gone; experiences a slight degree of weakness and stiffness in the hand, the back part of which and the wrist are in some places of a livid, in others of a yellow colour. The bandage to be continued a few days longer.

— *9th.* Feels quite well; desquamation of cuticle going on over the back of the hand. I saw her two days after, when the hand was quite well.

Case 2nd. Nov. 16, 1832.—Mr. H. aged 46, of a melancholic temperament and spare habit, was seized with a rigor four days ago, which lasted nearly two hours. Complains now of headach, thirst, pain and swelling of the right foot and ancle, which are in a high state of inflammation, and on which there are several vesications; redness extends all over the foot and ancle, and about five inches up the leg. Pulse 118, firm and small; tongue brown and dry; skin hot and dry; bowels confined; has passed three very restless nights, and is confined to bed. *Ft. V. S. ad* oz. xv. *Ung. Cetacei*, spread on lint, was applied over the vesications, and the foot, ancle and leg firmly bandaged. He was directed to take *Hydrarg. submur* gr. iii. and *Pulv. antimon.* gr.iv., and six hours after *Magnes. sulph.* oz. i.

— 17*th. Mane.* Has passed a comfortable night, during the greater part of which he has slept. Since two hours after the application of the bandage he has felt scarcely any pain or burning sensation in the foot. Bowels have not yet acted, the salts having been taken only an hour ago. Pulse 86, weak; tongue and skin becoming moist; redness, except on three or four small places, gone; swelling very much diminished, and very unequally diffused, owing to the application of the bandage. A little discharge from some of the vesications, the others dry. *Ung. Cetacei* to be discontinued; vesications covered with *oxyd. zinci*, and the foot, leg, and ancle firmly bandaged as before, a piece of lint being interposed between the skin and bandage.

Vespere. Felt a considerable degree of pain, which continued nearly an hour after the application of the bandage, since which the parts have felt quite easy. Bowels have acted freely. Bandage removed; redness entirely gone; swelling scarcely perceptible; no discharge from the vesications; feels comfortable in every respect. Bandage to be applied as before.

— 18*th.* Has felt no pain since yesterday. Pulse 76 natural; tongue moist; appetite good; bandage removed; redness and swelling entirely gone; desquamation of cuticle going on; considerable discolouration of a yellow and livid hue on several parts of the foot; a dose of salts and senna to be taken.

— 19*th.* Is walking about and feels as well as usual, excepting a slight weakness of the foot and ancle. Bandage to be continued.

— 21*st.* Feels quite well.

Case 3*d.*, *Dec.* 19, 1833.—Mrs. R. aged 54, of a sanguine temperament and rather spare habit; complains of pain and a sensation of burning in the left foot and leg, extending from the toes to nearly the knee, accompanied with violent headache, debility, and restlessness. Disease commenced with several rigors two days ago. Pulse 122, small and firm; tongue dry; skin hot and dry; bowels confined; the foot, ancle and leg are very red, much swelled, and pit on pressure; three small vesications on the instep. 16 oz. of blood were taken from the arm, a bandage tightly applied from the toes to the knee, and a saline aperient given.

— 20*th*. Feels greatly better; pain and swelling nearly gone; pulse 90; bowels open; tongue still dry; heat of skin much diminished; bandage again applied and aperient to be repeated.

— 21*st*. Is nearly well, a very slight degree of swelling continuing; pain and redness gone.

— 23*d*. Feels quite well; no redness, pain, or swelling; bandage to be continued.

The subject of this case has been for some years occasionally affected with œdema, arising from disease of the heart. I saw her about a month ago, when she informed me that she had experienced no return of erysipelas of the leg, and that her health had been considerably improved since that attack.

I might have added a considerable number of analogous cases, but I consider it superfluous, as all of them have been precisely similar in their results, having treated every case that has come under my care during the last twelve years on the same principle, with uniform success.

It may not be amiss to state, however, that I was led to employ bandages for the cure of Erysipelas in consequence of observing the effect produced by the pressure of my hand continued a few minutes on an erysipelitic surface.

In the case I allude to, I saw the disease after several days standing. Leeches had been repeatedly applied and the part kept cold with saturnine lotion; notwithstanding, the disease extended, the back of the hand became enormously swelled, and began to present a sloughing appearance. The acute stage had evidently passed. I applied my hand with considerable force, and on its removal a few minutes after, the swelling of the part covered with my hand had greatly diminished. I immediately applied a bandage tightly, and on its removal about eight hours after I found the parts nearly well.

In regard to the modus operandi of the bandage, it appears to me that inflammation consists in arterial capillary engorgement, which, when existing to a great extent, produces considerable obstruction to the circulation; that the bandage mechanically diminishes the size of these capillaries and enables them quickly to regain their former size and contractility.

ARTICLE IX.

On the Mean Temperature of the Ground at Various Depths.

By F. RUDBERG.*

AT the end of December 1832, three thermometers, by my suggestion, and at the expense of the Academy of Sciences at Stockholm, were put in the ground at that place. They were filled with mercury, and were compared while in the vertical position with an accurate thermometer, so that the influence of the mercurial column was provided against. The thermometers were placed in glass tubes, which were shut at the bottom by perforated stoppers, and filled with fine sand. The depths at which the balls of the three thermometers were placed, were one, two, and three feet respectively. The place where they were buried lies in the middle of that considerable plain on which the astronomical and now also the magnetical observatories are situated.

The observations began in December of the above year; but during the first six months they were made only once a day. After that, however, the thermometers were observed three times in the day, at 6 A.M. and at 2 and 9 P.M. As the natural equilibrium of temperature would of course be disturbed by digging up the earth, and a considerable time would be requisite to allow this to return to its usual state I shall here omit the observations of the first half year, and state only those from the 1st. of July 1833, to the

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* From Pogg. Ann. xxxiii. 251.

1st. of July 1834. The monthly means of these are the following:—

		TEMPERATURE AT THE DEPTH OF		
		ONE FOOT.	TWO FEET.	THREE FEET.
1833.	July . . .	60·548 F	59·000	56·966
	August . .	55·616	55·456	55·184
	September .	53·924	53·610	53·474
	October . .	48·146	48·344	49·262
	November .	39·002	40·316	42·206
	December .	33·458	35·186	37·004
1834.	January . .	29·282	31·244	32·720
	February . .	31·316	31·964	32·432
	March . .	32·640	33·134	33·440
	April . . .	38·048	37·436	36·932
	May . . .	48·020	46·562	45·104
	June . . .	56·570	54·500	52·312

If we take the mean of the result of each thermometer, then will the mean annual temperature of the ground at Stockholm be,

At the depth of 1 foot 43·880
,, 2 feet 43·898
,, 3 feet 43·906

Whence, it follows *that the mean temperature of the ground*, at least to the depth of three feet, *is independent of the depth;* and in all probability this proposition will be correct for all depths, till the point where all variation of temperature ceases.

The table shews, besides, that temperature at the end of September and the end of March, or at the time of the vernal and autumnal equinox, is the same at all these depths.

Although more observations may be required to settle these two propositions, I have, nevertheless, thought it proper to draw the attention of meteorologists to them that they may try their accuracy in other places.

This mean temperature of the earth is greater than the mean temperature of the air at Stockholm, which is only 42·24 F.

Article X.

SCIENTIFIC INTELLIGENCE.

I.—*Ashmolean Society of Oxford.*

The first memoir printed by this Society is entitled, "On the Achromatism of the Eye. By the Rev. Baden Powell, A.M." &c.

It is well known that when rays of light are inflected by a lens they undergo a deviation, by which they are prevented from concentrating in the same point or focus. This aberration gives origin to the production of colour at the foci of lenses, and constituted a great imperfection in refracting telescopes until the discovery was made, that a compensation for the deviation of the rays of light might be effected by employing compound lenses. Those telescopes in which this improvement was introduced were termed achromatic. Now, as there appears no compensation in the eye for this aberration, it is natural to inquire into the reason of our seeing objects without prismatic colour. Such is the question which Professor Powell undertakes to investigate in the present paper. He presents us first with the opinions of various philosophers in reference to the subject, and then supplies us with inferences drawn from his own experiments. D'Alembert admitted the want of achromatism in the eye, but considered the aberration very small. Euler held an opposite opinion, and Dr. Maskelyne refuted the arguments of Euler. Dr. Wells has observed that the eye has no principle of achromatism, and Sir David Brewster says that "no provision is made in the human eye for the correction of colour, because the deviation of the differently coloured rays is too small to produce indistinctness of vision." Mr. Coddington states that the eye, when employed in its natural and proper manner, is achromatic. The fact is, that we see objects without the slightest degree of prismatic colour or indistinctness. The question then is, how can this be reconciled with theoretical considerations? Mr. Powell, by ingenious calculations, has inferred that in such a combination as the eye, exact achromatism is perfectly possible in theory, and that the principle of its achromatism, although not effective in oblique excentrical rays, may be in general achromatic for direct rays. He gives the results of a series of experiments, in which he has "endeavoured to ascertain directly the actual prismatic dispersions of the crystalline and vitreous humours, by measuring micrometically the separation of the different parts of the spectrum of a line of light produced by looking through a prism formed of each medium, from the eye of an ox, between inclined glass plates." From which he concludes "that the media of the eye have as nearly as possible those dispersive powers and relations of indices for the different rays, which theory requires for producing achromatism by means of a single lens, when the focus is formed in a dense medium."

February 13, 1835.—Mr. Twiss of University college exhibited some specimens of the papyrus from Syracuse, both in its natural and manufactured state. He read some observations upon it, describing the locality where the plant grows on the banks of a small stream issuing from the fountain of Cyane, near Syracuse. It is now manufactured merely as a curiosity.

Some discussion took place on the supposed identity of the papyrus with the lotus.

Mr. Twiss exhibited to the Society a series, almost complete, of the silver and bronze coins of the Roman republic, and read a dissertation upon them.

In this paper the author commences with observing the gradual decline in weight of the As from the time of the kings through the successive ages of the republic. The value of the copper is compared with that of the silver coinage; and the author is of opinion that the rise in the value of copper is chiefly accounted for from the diminution of the supply, both from the exhaustion of the mines, and the interruption of the commerce with the Carthaginians, as well as from the circumstance of copper being re-exported to Sicily; these causes acting more powerfully about the time of the second Punic war, when the As was diminished to an ounce, from its original weight of ten or twelve. The last diminution, to half an ounce, took place in the time of Sylla. Silver was introduced into the currency after the conquest of Campania and Lower Italy. Observations are made on the silver coinage, and particularly on the devices appearing on them: and the author then gives a general sketch of the financial arrangements, and state of the currency, at successive periods of the Roman history.

February 27th.—A paper was read by the Rev. E. T. Bigge of Merton College on the natural history of the wasp.

The object of this paper was to correct the mistakes into which several writers have fallen, and to state the results of the author's own observations on two species, the Vespa Vulgaris and Vespa Britannica.

The former is common in all parts of the kingdom; the latter, though occasionally met with in the southern counties of England, is abundant in the northern districts, and in Scotland, as well as in the northern parts of Europe. The V Vulgaris of Linneus is the V Britannica, the French having called that species *vulgaris*, which was most common, and which formed its nest in the ground. The V Vulgaris of the present entomologists is the V Gallica of Linneus.

Leach gave the name Vespa Britannica to the tree wasp. The points of difference between the two species are as follows:—

1. The tree wasp (V Britannica) has a reddish-brown spot near the point of insertion of the wings, which is seldom visible in dried specimens.

2. In the males and neuters the base of the antennae is yellow on the outer side, instead of being entirely black, as on the ground wasp, but the females often present exceptions to this distinction.

3. The tree wasp has two yellow spots on the back part of the corslet, while the ground wasp has from four to six.

4. The spots on the abdomen of the tree wasp are not so much detached from the black bands as in the other species, and less so in

the males than the females. Linneus drew a distinction between the hornets (V Crabro) and the true wasps, founded on these marks, which cannot be considered as decisive, because they vary in different individuals.

5. The tree wasp has more black upon the body generally than the other species.

6. The tree wasp is rather larger. 7. The organs of generation in the males of the two species vary considerably. 8. The abdomen in each species contains the same number of rings, viz. six in the females and neuters, and seven in the males.

Mr. Bigge states some interesting facts in illustration of the natural history of both species. Societies of wasps, as of bees, consist of three different classes of inhabitants, males, females, and neuters. The females, which are much larger than the others, are the large breeding wasps which appear in the spring. The neuters, or imperfectly developed females, are the common wasps which infest our houses and gardens, and form the majority of the colony. The males, about the size of the neuters, have longer antennae, a more slender form, and are destitute of a sting. The females, which alone survive the winter, early in the spring, having fixed on a suitable place for a nest, form a few cells, in which they lay the eggs of neuters only. Each nest is the work of a single female. The nests are often suspended from the beam of a shed, from the eaves of a house, from the branch of a young tree, or in a thorn hedge.

Mr.Bigge has observed them in the Scotch fir, elm, and beech, very frequently in larch trees, and still more so in goosberry bushes, but never in the silver fir, as stated by Mr. Rennie.*

The nest consists of from ten to sixteen layers of a paper like substance, procured principally from fir wood, and disposed one over the other in such a manner that each sheet barely touches the next. This structure enables it to resist the heaviest rains. In its earliest state it does not exceed an inch in diameter, and contains five or six cells only.

It is formed of two semicircular layers of the paper, the upper one projecting a little over the other, so as to shoot off the rain, a hole being left at the bottom large enough to admit the female wasp. As soon as the first workers quit their cells they begin the task of enlarging the nest, and of adding fresh layers of cells, in which the female immediately deposits more eggs. Mr. Bigge states that the nest is enlarged from one inch to twelve in diameter, and considers that Leach is in error when he affirms that wasps build two nests in the year.

Is not the loose structure of the external covering intended to facilitate its expansion?

The egg is hatched in eight days, and then assumes the form of a grub. It is then fed by the female for thirteen or fourteen days, when the grub covers the mouth of its cell with a silky substance. It remains in this state for nine days, and then eats its way through the covering, and joins the rest in the labours of the nest. As soon as the neuters are hatched the care of feeding the larvae devolves upon them. The males appear to employ themselves in cleaning and preparing the cells for successive broods.

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* I have frequently observed nests situated on wild rose bushes (Rosa *tomentosa and canina*,) in Scotland. The choice of these shrubs by the wasps is probably to be ascribed to the facilities which they afford for obtaining food.—EDIT.

Mr. Bigge has never found, in any single instance, a male larva in the cells appropriated to females. He has repeatedly found male grubs in the upper layers, which are devoted to neuters, but never the contrary. The beautiful arrangement by which the layers in the nest are attached to each other so as to allow room for the wasps to walk between them deserves attention. In the ground nests the supports or braces are round, like small columns, and dispersed at irregular distances. The upper end is spread along the edges of three cells so as to divide the pressure, and yet allow room for the grubs to work their way out when they are come to maturity. In the tree nest, instead of pillar like braces, thin slips of the paper of which the whole nest is composed but made stiffer for this purpose, are continued along the edges of a number of cells, so as not to interfere with the inmates, and are finally fixed to the layer below.

The author has never seen a nest of either species, in which he did not observe after 9 o'clock in the summer months, a sentinel watching the entrance to the hive. He has sometimes thought, that he could discern a second sentinel, behind the first one. A lantern held near the sentinel does not disturb him, but on touching the ground near him, he instantly disappears for a few seconds, and the inhabitants sally out immediately. Several wasps pass the night in summer on the outside of the tree nest, but the sentinel is notwithstanding always at his post.

The ground nest has two apertures, one for entry and the other for exit. The tree nest has usually only one, but in large colonies there are two, at each of which a sentinel is stationed. It is curious, that if we stop up a wasp's nest, the returning wasp will not sting the aggressor, while those which escape from the inside will attack him instantly. The grub of a species of volucella is found in the nests of wasps. An ichneumon as large as the wasp itself, with a black head, yellow abdomen with a dark streak down the back, black legs and under wings, and dusky upper wings has been observed by Mr. Denison, and another (Anomalon Vesparum) by Mr. Wood.

Mr. Twiss mentioned a peculiar kind of wasp's nest which he had observed on the Cactus in Sicily. The author suggested the query, whether it was not the Epipone Fidulans, sometimes found also in England.

Dr. Kidd read a paper on a species of manna produced in the neighbourhood of Mount Sinai.

It is a gum which exudes from a species of tamarisk, through minute punctures in the bark made by insects. It drops upon the ground in a liquid state, but congeals by the cold of the night. It is eaten by the natives, and has a sweet taste.

Though denominated by Niebuhr, "manna Israelitarum," the author argues that it must not be confounded with the manna mentioned in Scripture, since the quantity produced at the present day would be utterly inadequate to the supply of so numerous an assembly.

The paper was illustrated by a large coloured drawing.

Mr. Plumptre stated, that a deposition of manna had been observed by Mr. Gray, in the same part of Arabia, at a distance from any trees, apparently condensed, or precipitated from the atmosphere, and appearing deposited on objects like hoar frost.

March 13*th*.—An anonymous paper was read, entitled "Physical elucidation of a passage in Horace."

It appears to the author of this paper, that notwithstanding all the difficulties which have been felt, and the learned ingenuity which has been exercised upon the passage, (Ode 10. bk. iii.)

"*Puro* numine Jupiter,"

the epithet "Puro" may be allowed to stand as the true reading, being entirely conformable to the known belief of the ancients; according to which the *coldness* of the night was inseparably associated with the *clearness* of the sky. This impression, though sometimes mixed up with fanciful conceits as to the effect of the moon's rays, &c. was very probably grounded on extensive observation, though they might be little aware of the cause to which the effect was to be referred. This is now well understood to be the radiation of heat from the earth's surface; which goes on more freely, or in other words, the earth cools more rapidly, at night (cæteris paribus) under a clear sky, than under a screen of clouds, which intercepts the radiant heat.

An anonymous paper was read "on a difficulty in the history of the publication of Newton's Principia."

In Birch's History of the Royal Society, (vol. iv. p. 486.) the following passage is given, as extracted from the journal books of the Society:

"Minute of the Council. 1686, June 2.

"Ordered, that Mr. Newton's book be printed, and that Mr. Halley shall undertake the business of looking after it, and printing it at his own charge, which he engaged to do."

But it also appears, that at a meeting of the Council on the 19th of May (1686) it was resolved "that the MSS. should be *printed at the Society's expense,* and that Dr. Halley should superintend it while going through the press."

Yet this seems to be contradicted by the language of the first extract; and the difficulty has been remarked by the learned author of the "History of Hadley's Quadrant," which has appeared in several recent numbers of the Nautical Magazine. He expressly observes in a note, "It is hardly possible to conceive, that the R. Society, after undertaking to publish the work, could, either from deficiency of funds, or from any other cause, have thrown the burden of it upon Halley. But the minute is unintelligible, if it does not imply, that he either engaged for some positive expense, or gave up some serious remuneration, to which he would have been justly entitled in the prosecution of the publication."

The author, however, wishes to submit, whether the whole difficulty may not be cleared up at once, by the simple consideration of the *punctuation* of the first extract; viz. if we read it thus:

"That Mr. Halley shall undertake the business of looking after it and printing it,——at his own charge:" that is to say, shall, at his own charge of whatever trouble or minor expense may be incidental to it, undertake the superintendence of the printing.

Professor Powell communicated a paper on the present state of the question respecting the theory of the dispersion of light.

The grand optical discovery of Newton referred to the unequal refrangibility of those primary elements of light, which were designated *generally* as the *red, blue,* &c. rays. Each of such species of light was observed to have its refrangibility different, and increasing from the red to the blue end of the scale. Newton's successors soon found that the refrangibilities were not only different among themselves for the parts of the spectrum formed by a prism of the same substance, but followed no perceptible proportion, when compared from one medium to another. The only attempt to estimate them numerically, consisted in finding the mean refractive index for the substance, and inferring the indices of extreme rays from the amount of separation or dispersion observed. Thus up to a late period, the indices were only determined for the red, blue, and mean rays vaguely and without exact definition; as it depended only on the judgment of the eye to say how far the red (e. g.) should be considered to extend, and where the yellow should begin; and what point of the red or yellow, &c. should be taken for the point of measurement. Among the refractions observed thus vaguely for different media, no apparent relation or connexion could be traced: and no theory, whether of emission or of undulation, appeared to afford any explanation of the phenomena. Indeed, all comparison between the rival theories on this point might have been spared, since not even the *law* of the phenomena, nor even an exact knowledge of the facts themselves, had been obtained. *All* theory, was, therefore, premature.

More recently the singular fact of finely-marked dark lines being seen to cross all parts of the spectrum (discovered independently by Dr. Wollaston and Mr. Fraunhofer) afforded the means of more accurate measurements. They formed precise points, assuming different relative positions for the different media employed: and by means of them, Mr. Fraunhofer determined with the most elaborate precision, the refractive indices for seven principal lines or definite rays, in each of ten different transparent substances. Thus science obtained the first important requisite, without which no satisfactory investigation of causes can proceed, *exact numerical data.* But the more exact the data, still only the more palpable was the seeming absence of any law.

Further, Newton had determined the lengths of those intervals or periods (which he called *fits,* but the undulationists *waves*) which, by whatever name they may be called, have a real existence in the nature of light. These are different for the different rays. Newton determined them only for the red, blue, &c. rays in the same general sense as before; but Fraunhofer measured them accurately for the seven definite rays above mentioned. Here then is another set of numerical data: and the first obvious inquiry towards investigating a law would be, *Can any relation be traced between these two sets of data* for different rays and different media?

This question *must* be examined before we can pretend to enter on any discussion of *theories*. And the present state of the inquiry is precisely that in which the answer to this question forms the sole important and legitimate object of attention. An attempt to answer it, has formed the subject of the author's labours for some time past, by a comparison grounded on a formula deduced from M. Cauchy's researches; which appears to give a very close accordance. The results will shortly be published.

II.—*Royal Institution.*

Comparison of the two theories of Electricity. 3rd April, Dr. Ritchie stated, that at present there are two theories which have been proposed for the explanation of electrical phenomena. One which is the simplest theory, supposes that they depend upon the existence of a fluid universally diffused through matter and space, the particles of which repel each other inversely as the square of the distance. If we abstract a portion of this fluid from a body, the latter becomes negatively electric: while if we add a portion, we produce the phenomena exhibited by positive electricity.

Another theory considers electricity to be a compound substance, consisting of two elements, positive and negative electricity. None of the phenomena are observed until this fluid is decomposed, and then a portion of it goes to the attracted body.

Upon this supposition we can best explain why divergence of the gold leaves in an electrometer should take place in vacuo. Perhaps, the fluid may be the ether, to which the phenomena of light seem attributable. But unless it be a compound fluid, it is not possible to explain the fact, that when a vessel, in which there is a small aperture at the bottom is filled with water, when it is attached to either conductor of the machine, there is formed a regular stream through the aperture.

Now, if there were two fluids the same appearances should not be exhibited at both conductors. When a bit of wax is attached to either conductor, heated, and then the machine set in motion, the wax is thrown upon white paper held below it, in the form of a beautiful thin film. It is difficult to explain the fact, that when we place a card between two fine points, and discharge an electric jar through them, the card will be pierced opposite to the negative point. The reason perhaps is, that the paper is a better conductor of one of the elements of the fluid than of the other. The card on each side presents the same appearance, which leads to the conclusion, that a fluid has passed through from both sides.

According to the theory of Franklin, the actual particles of matter repel each other, which is contrary to the law of gravitation.

By considering electricity as a compound body we can explain also the electrophorus.

In order to confirm the idea of the existence of two elements, we can by a beautiful experiment separate one element from the other.

If we place two conductors united by their contact with fine points, at a considerable distance from the conductor attached to the machine, charge the machine, and then suddenly remove one of the separate conductors to the electrometer, we obtain a divergence in the gold leaves of the latter. To determine the nature of the electricity which has thus been separated is easily accomplished, by means of a glass rod excited, or a substance covered with a resinous coating.

Dr. Ritchie suggested that by a modification of the galvanometer, base coin may be readily detected. A bad sixpence which he submitted to examination produced a very rapid deviation in the needle. He is of opinion that $\frac{1}{1000}$ of copper mixed with silver might be by this method appreciated.

Dr. Ritchie endeavoured to afford an explanation of Dr. Faraday's experiment, in which, the spark was elicited in a long wire, by the consideration, that one particle of light does not communicate light. Now, in the long wire the quantity of electricity was smaller than in the short wire, but took a longer time to arrange itself.

The able lecturer exhibited an electro-magnetic machine, in which he had devised some improvements, by which combustion and decomposition can be as readily effected and more conveniently than with a voltaic pile. This affords an excellent instrument for class room experiments.

Dr. Lardner on Halley's Comet. 10th April. Up to the time of Kepler, philosophers were in the habit of forming systems and cutting down nature to suit their own theories. He produced, however, a revolution in the science of astronomy, and proceeded by the sure process of induction, to study the nature of the planets. He selected Mars, because it is nearer us than any of the other planets. He found it impossible that this planet could revolve in a circle of which the sun is the centre, an opinion which had been long entertained. Still he was unwilling to abandon the idea, that its orbit was a circle; and he endeavoured to ascertain, if it might not revolve in a circle with the sun out of the centre. But he could not reconcile its motion even with this supposition. He then banished the idea that its orbit was a circle, and by a fortunate or instinctive guess, concluded that it was an ellipse. Now, this is a very remarkable circumstance, because it varies so very little from a circle, that if it were delineated on paper, it would be impossible so say that it was an ellipse, without very accurate measurement.

By analogy, he extended the conclusions to which he had come, in regard to Mars, to all the planets. He further demonstrated, that by the planets, equal areas are described in equal times. Newton followed out this law, and shewed that the attracting force diminishes with the square of the distance. He found by reversing this problem, that the orbit must be a curve, of which an oval forms an instance.

The ellipticity of the orbits, it was shewn, however, does not depend upon physical laws, but upon the will of the Creator, because in proportion to the force with which they were launched into space, they would follow the curve of an ellipse, of a parabola or hyperbola.

All the planets are collected in the zodiac, from what cause we are not aware, and they all revolve in the same direction. Such are the principal features in the motions of the planets. Now, with regard to comets, we find that they differ as much as they possibly can do consistently with the laws of nature. The orbits of some of them are extremely elliptical, of others almost circular, so that they follow no constant law. They have no preferable plane in which they move, some moving at right angles, others not. In short, they are a kind of physical vagabonds. Some of them move direct, or in the direction of the planets, others retrogade; 68 move one way, 69 the other. They possess no characters such as the planets possess, as the satellites of Jupiter, the belts of Saturn, &c., by which we can identify them, for they are surrounded by a mass of vapour, and are therefore, seen by us indistinctly; sometimes their tails grow longer, sometimes shorter. The comets can only be seen at the focus of their orbits or at that point where they are not too far from the earth, and not too near the sun. But as this position is the very point where curves of an ellipse, parabola or hyperbola, correspond, we must have recourse to some other method than a single observation, to determine their orbit. This is done by their periodicity. If they return periodically, we are sure that their orbit is an ellipse; if it is a parabola or hyperbola, they will shoot off into space and never appear again. Now, it is easy to calculate the degree of ellipticity of the orbit, because Newton has demonstrated in his Principia, that the squares of the periodic times are to each other as the cubes of the distance of the respective planets from the sun. Knowing, therefore, the periodic times, the ellipticity and size of the orbit can readily be deduced. To this point, therefore, Newton brought the question—He said, "the orbit of comets is an ellipse, but I have not time to determine the axis: I leave this to succeeding astronomers." Halley took it up in 1700, where Newton left off. Before his time, 425 comets had appeared, but 24 only had been observed, the rest were only seen From the observations which had been made upon these 24 comets, he calculated their courses. He found the elements of one which appeared in 1607, to agree with one he had observed in 1682, and on examining other observations, he found, that the following table could be formed in reference to one comet.

Years.	Periods.
1305	
1380	75 years.
1456	76 ,,
1531	75 ,,
1607	76 ,,
1682	75 ,,
1759	77 ,,
1835	76 ,,

He ascribed the differences in the periodic times to the attraction of Jupiter and Saturn. He guessed this as if by instinct, for he really had not at the time the philosophic means of determining it. In 1757, Lalande proposed to Clairaut, the calculation of Halley's comet which was expected to return speedily. They were assisted by a French lady, the wife of a chronometer maker. The calculation was enormous, because the orbit must be divided into degrees, and each degree requires as great a calculation as the whole orbit. They tell us, that they were employed from morning to night, not excepting meal hours, incessantly for six months in this computation.

Clairaut was so nervous that he hurried his calculation before the Institute, although he had not completed it. He stated, that the comet would reach its perihelion on the 4th of April, but that it might be seen sooner.

Voltaire has said, that the philosophers did not go to bed in the beginning of the year, so anxious were they to observe it. Notwithstanding their anxiety, it was discovered on Christmas day, 1758, by a farmer in the neighbourhood of Dresden; and then by Messier in the middle of January at Paris. It reached its perihelion on the 13th March. Now, although Clairaut was not quite correct as to the day, the only wonder is, that he should have been so accurate, for as he said, when a body traverses a space of 1500,000,000 of miles beyond our sphere of observation, how do we know but that some other planet may act upon it and influence its course. In 25 years the planet Herschel was discovered, which it was proved, did actually operate in producing the effect which Clairaut had surmised.

1st May. The comet of this year will appear in the end of October or beginning of November. The cause of this uncertainty, is our want of knowledge of the mass of the planet Herschel. Four different days have been fixed on by calculators. These are,

31st October,	4h.	46′	58·8
5th November,	7 ,,	40 ,,	
8th ,,	4 ,,	48 ,,	
10th ,,	2 ,,	30 ,,	A.M.

On the 7th of October, it will be near the head of the great bear, and will be visible after sunset. On the 11th, it will be near the tail of the same constellation. On the 10th, it will make its nearest approach to the earth. It is probable, that it will be of less magnitude than it was in 1759, if we are to judge from its most recent history; but if we go back to the appearances which it presented at its first periodic times, this conclusion is not warranted. Its history has been traced back to 150 years before Christ. In 54, it was also observed, and was so bright that the birth of Mithridates, who came into the world in this year was ascribed to it. After this period it must have returned five times without having been noticed. In 323 it is again recorded. In 399 it again appeared, when it was of great magnitude. In 550 it is again recorded, and also in 930, and 1250. In 1305 it possessed great splendour, and in 1456 its tail was of such enormous extent that it occupied two thirds of the space comprized between the horizon and zenith, or above 1,500,000,000 of miles. In 1531 it had diminished in size. In 1607 it was still less, and was discovered by Kepler when returning from a dinner party. The tail was invisible. In 1759 it had the appearance of a fixed star surrounded by some luminous matter. Hence, it is probable that this year it will be smaller. But, at the same time, we cannot fail to remark that it has increased and diminished without any regularity.

There are only two suppositions which present themselves to account for its non-appearance should that happen, viz.: 1. That a planet may exist beyond Herschel which may exert its influence on it and draw it out of its orbit, or 2. it may have met with another comet during the interval which has elapsed since it last appeared, which may have carried it off.

There are only two other comets which have been observed to appear periodically. These are Encké's and Beile's comets; but these are of very small magnitude. Encké's has appeared two years sooner than can be accounted for by the laws of gravitation. Beile's was discovered in 1826, since which year it has only returned once, but was accelerated one day beyond the results of calculation. These are the two arguments for a resisting medium, and the existence of an ethereal fluid.

In June 1770, Messier discovered a brilliant comet within the orbit of Jupiter, and Lexell computed it. Previously it was thought that comets moved in a parabola. He inferred, however, that it moved in an ellipse, and that it would return every 5½ years. It did not return, however, as he had predicted. Laplace, however, shewed in the 2nd chapter and 9th book of his *Mecanique Celeste*, that in January 1767 it must have entered within the attraction of Jupiter, and was acted upon by that planet so as to give it an ellipse of 5½ years for its orbit, that at the end of the first 5½ years the sun obscured it, and at the 11 years Jupiter crossed its orbit and entangled it again. This was a splendid triumph of mind over sense, for Laplace first gives a general formula for calculating the retardation of a comet with a given track, anterior and subsequent to its appearance, and then merely takes the comet of 1770 as an example for the application of the rule.

If the mass of this comet were equal to that of the earth, the attraction exerted would shorten the year 10,000 seconds; but it has been found that the year is not diminished 2 seconds, and hence, it must be inferior to the mass of the earth. This comet afterwards went in directly among the satellites of Jupiter without disturbing them in the slightest degree: from which circumstance we can scarcely fail to conclude that it was lighter than light. Much discussion has taken place with regard to the nature of the constitution of comets. Sir John Herschel observed a fixed star through the head of a comet. It has been said that the direction of the tail is influenced by the sun, but this is incorrect, because some comets have had two tails, one pointing to the sun, and the other from it, while others have had six tails all pointing in various directions, and vacillating, so that comets may be said to wag their tails. Comets do not shew phases like the moon, because they are not solid, but are more like fleecy clouds when the sun shines upon them. M. Arago suggests that the only method of determining whether they are essentially luminous or not must be by the investigation of their phases, and the comparative intensity of their light by means of photometers. It is remarkable, that they grow larger as they recede from the sun. Sir John Herschel has offered two explanations of this: 1. By considering them to consist of particles which have little cohesion, and which move in a variety of orbits, and get closer as they approach the sun: or 2., and this is the most ingenious attempt at the solution of the difficulty; that when cooled the particles condense as we observe in steam issuing from a kettle, the portion nearest the source of heat being invisible, while at some distance a cloud of vapour is observed.

Five or six hundred comets have been recorded, but of 137 only have the tracks been observed.

These follow no regular angle of inclination; neither are the planes of their perihelia nor their ascending nodes regular. The times of their perihelia are also irregular. These are

January	14
February	10
March	8
April	10
May	9
June	11
July	10
August	8
September	15
October	11
November	18
December	13
	137

The number of those whose course is direct is	69
Retrogade	68
	137

If we assume that there are 30 comets in the orbit of Mercury, and no more, (but assuredly there are more; these 30 have been observed), then within the orbit of Herschel there will be above 3,000,000 of comets, or 7,000,000 within the solar system.

Note.—Olbers is of opinion that people in general will allow the comet of this year to pass without notice, in consequence of the poor supply of light. The following table of its course is taken from a short paper by Arago, in the *Annuaire* for this year. By means of it the track of the comet may be studied on the celestial globe, by those who are not familiar with the geography of the heavens, and their knowledge thus acquired may be applied to the real objects.

The comet will be found

On the 20th August, 1835	near ζ in the Bull
28 "	between the Twins and Auriga
21st September	in Auriga (the charioteer)
3rd October	in Lynx
6th "	in the Great Bear
11th "	„
12th "	in Bootes
13th "	in the Crown
15th "	between Hercules and the Serpent
19th "	in Ophiucus
16th November	near η of Ophiucus
26th "	in Scorpio near Antares

Mr. Wheatstone on Speaking Machines. 8th May.—Mr. Wheatstone gave an account of the different attempts which have been made to invent speaking machines, from the time when the oracular responses were delivered at Delphi, through the period when a speaking head was exhibited by the Pope towards the end of the 10th century, and others afterwards, by Roger Bacon and Albertus Magnus, with the impositions which were practised upon the credulous, to the present time, when the principle of a speaking instrument has been developed by Mr. Willis. Van Helmont was one of the first persons who wrote upon the adaptation of the organs of voice to the articulation of the letters. He considered that the letters of the alphabet constituted the order in which articulate sounds were naturally produced, by the structure of the tongue and larynx; that when one letter is uttered the tongue is in the proper position for the pronunciation of the subsequent one. By attending to the circumstance, that several different sounds are formed, merely by raising or depressing the tongue slightly, as in the sounds Aw, Ah, Ae, A, E, it was easy to produce them by means of a tube with a reed and terminating in a bell. Mr. Willis also effected the same object by using a long tube with a reed, adapted so as to be capable of being lengthened or abbreviated at pleasure. He found, that in the pronunciation of the vowels, i, e, a, o, u, it required to be shortest with the first, and in uttering the subsequent letters to be gradually lengthened. In this way, it was easy to measure the length necessary for each note. When Ae was pronounced, the tube was 1 inch long, Aw 3·8 inches, Ah 2·2 inches, A 0·6 inch, E 0·3 inch.

Mr. Wheatstone exhibited a copy of a speaking machine which was invented in Germany, and afforded a specimen of its vocal powers. The words, *mamma, papa, mother, father, summer,* were distinctly pronounced. The instrument consisted of a pair of bellows, to which a tube is adapted, terminating in a bell, the aperture of which is regulated by the hand, so as to produce the articulate sounds.

III.—*Metropolis Soft Spring Water Company.*

A printed letter has been sent to the Editor, with this title, signed "A Manufacturer," containing some observations which ought to be generally known. The projectors of this company assume that the London basin "contains a subterranean lake, and an inexhaustible supply of water." The writer informs us, that in two large wells and two bore holes which have been made in his manufactory, at different periods, between 1810 and the present time, "the supply of water though at first abundant in each of them, has gradually and uniformly diminished in all. The principal well, nearly a new one, obtains its supply from the whole of the thickness of the quicksand; for the lower end of the bore pipe which terminates with a 10 inch opening, is bored full of holes for the last 30 feet and rests upon the face of the chalk." Notwithstanding, after affording an apparently inexhaustible supply for some years, in the course of last summer (1834) the water was repeatedly drawn down to the suction guard, which is 90 feet from the surface, and the working of the engine was often stopped for the purpose of allowing the water to collect. He states, that when one of the wells mentioned has been pumped for some hours, the water in another well, at a distance of 3 miles, is considerably lowered. And very properly observes, that as many of the largest manufacturing establishments are dependant upon these springs for their supply of water, they have a right to ask from what source they are to expect compensation?

These facts, which we believe to refer more immediately to the southern portion of the metropolis, are consistent with the experience of the inhabitants of the northern part also, where for the last two months, many of the wells have been dried up. The bill for the incorporation of the company has been read a first time in the House of Commons. But before it proceeds further, in justice to all parties, it will be absolutely necessary that more information should be collected.

IV.—*Address to Meteorologists.*

At the suggestion of Sir John F. Herschel, *(Athenæum, April)* the Scientific Society at the Cape of Good Hope has agreed to undertake to make horary observations of the barometer, thermometer, wet and dry thermometers, clouds, winds, meteors, &c., &c., on four fixed days in each year: viz. 21st of March, 21st of June, 21st of September, and 21st December, (unless any of these days should fall on a Sunday, in which case, for the 21st substitute the 22nd,) at the commencement of each hour, (per clock) mean time at the place for 36 hours, beginning at 6 o'clock in the morning of the 21st, and ending at 6 o'clock in the evening of the 22nd. Sir John Herschel himself adds, " If possible, get meteorologists in England, and elsewhere, by land and by sea, over the whole globe, to set apart these four days as great meteorological festivals, when every man is to be at his post."

It is only necessary to add that a portion of the " Records" will be preserved for the insertion of a summary of such correct registers as may be kept in this country, on these days; we hope that meteorologists will be up and stirring.

V.—*Postscript to Mr. Walker's Paper on the Adjustment of the Eye, &c.*[*]

Sir, *Manches terMay 11th*, 1835.

May I request that you will do me the favour to insert, in your next Number, the following postscript to my paper " On the Adjustment of the Eye, &c."

To make my account complete, I ought, perhaps, to have added, that the converse of the proposition is also established by the experiments which I have made with the optical instrument described; for, with a contracted pupil, distant objects are but obscurely represented on the retina, and those only which are well portrayed are such as stand out in strong relief. So that it is quite apparent that whilst on the one hand a contracted state of the pupil renders near objects distinct; on the other hand, to obtain a correct picture of distant objects, and more particularly a wide range of vision, it is essential that the pupil should be rather dilated. With the instrument adapted for the representation of distant objects, if it be desired to produce a perfect picture of a near object by altering the relative position of the lens and the retina, it is necessary to remove the latter to a distance of not less than two inches from the former, That a corresponding change of this description can take place in the human eye will hardly be supposed.

I am, Sir,
Your very obedient Servant,
John Walker.

To the Editor of the " Records of General Science."

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[*] See vol. i. p. 368.

VI.—*Optical Experiment.*

THE following is contained in a letter to the Editor, from Professor Stevelly of Belfast.

"Mr. Patterson, a young gentleman of this town, of very considerable literary and scientific acquirements, and one of the Vice-Presidents of our Natural History Society lately informed me that he had been greatly surprised while walking past the iron railings of our College, and at the same time looking through them at the snow covered country, the sun also shining brightly, and being near the horizon, to observe, that as the rails and open spaces came alternately before his eyes, a very vivid play of colours presented itself to his notice, the shades being chiefly reds and blues; but he thought he also observed other prismatic colours. On the next opportunity I had, the snow, however, being only on the distant hills, I tried the experiment myself, but as I walked at a slow pace, I was nearly supposing that my eyes being very defective were not fitted to make the observation, when I recollected that Mr. Patterson habitually walks very fast; I therefore quickened my pace very considerably, and was much gratified at observing, *after a few seconds*, that very vivid changes of colour did present themselves to my notice, but the predominant colour to me was a shade of pink, and some dark colours which I could not accurately distinguish alternated with it. The intervention of the opaque bars of the railing at equidistant intervals was no doubt the cause, and the entire effect would seem to me to prove that the retina takes different lengths of time to be impressed with the several colours sufficiently for the notice of them to be conveyed to the mind, as also that the time during which the retina remains under the influence of the impressions of the several coloured lights after the light itself had ceased to act is different. If this be the cause of the appearance I have attempted hastily to describe, it can very easily be put to the test of accurate and direct experiment, by an apparatus somewhat similar to the lately invented pleasing illusion, the stroboscope."

VII.—*Prevention of Dry Rot by Corrosive Sublimate.*

SIR,

HAVING seen a notice of Dr. Faraday's idea of the innocence of Mr. Kyan's application of the deutochloride of mercury, when used as a preventive of the dry rot in timber, may I solicit your opinion respecting the following queries:

1st. Will a ship built with timber, so prepared and sheathed with copper, be deprived of such sheathing by the elective attraction between its atoms and those of the salt?

2nd. Will there not be a succession of decompositions and of recompositions exerted between the saline matter of the sea the copper-sheathing and the salt, and of these sufficient to excite a galvanic action by which such preparation will be rendered inert?

Remaining, Sir,
Your humble servant,
J. H. L.

Rugby, April 8, 1835.
To the Editor of the Records of General Science.

As the permanency of the benefit resulting from the application of corrosive sublimate to prevent dry rot from affecting the timber of ships is matter of pure experiment, it would only be speculating to give any opinion at the present time upon the subject. But as far as the experiments have gone I have reason to know that the results have been highly satisfactory, not only with regard to the preservation of the timber, but also in reference to the health of the seamen, upon whom it was supposed by some, on what grounds it is not easy to discover, that the mercurial salt would produce deleterious effects; neither is there any reason for anticipating the detriment, which the queries of my correspondent suggest, to the copper sheathing from the same influence.—EDIT.

VIII.—*Mode of preserving Iron and Steel from rusting.*

SEVERAL methods of preventing instruments of steel and iron from oxidating are well known, such as covering them with mercurial ointment, grease, oil or marrow, or placing them in calcined lime. The former of these I have found the most effectual as well as the most convenient mode.

M. Payen has, however, lately proposed a new plan for accomplishing the same object. He found that a saturated solution of carbonate of soda mixed with its own volume of water, disengaged only $\frac{1}{1000}$ part of its volume of air, and preserved iron from rusting, and did not lose this power even when diluted with twenty-five times its volume of water. A saturated solution of borate of soda, as well as a mixture of water and ammonia, disengaged no gas nor underwent any contraction, but preserved iron from oxidating. Saturated lime water diluted with an equal volume of water possessed the same power. A saturated solution of potash diluted with 1000 and 2000 parts of water, preserved iron, but when saturated with a current of carbonic acid, the oxidation of the metal occurred as in common water. A saturated solution of potash diluted with 4000 or 3000 parts of water, had not the property of preventing oxidation, and upon turnsol this solution exhibited an alkaline re-action.

M. Payen, sensible of the impracticability of immersing surgical instruments in a liquid, suggests the propriety of forming a varnish the saturated solution of potash, and gum tragacanth.

He made a comparative experiment upon muskets, one of which he varnished over, and the other was left in its natural state. After a lapse of fifteen days the former was quite bright, while the latter was rusted. He considers that the solutions of soda will be preferable to those of potash, because they are less deliquescent. The effects of these solutions in preventing oxidation were so decided, that he compared carefully the consequences when iron was placed in common water. About 20 minutes after immersion a thin opaline halo surrounds it, which increases in size and intensity. At the end of an hour it is sensibly brown, and gradually a deposit begins to form on the greatest part of the iron, and at the bottom of the vessel.

IX.—*Communication by Egypt to India.*

THE subject of a short communication to India has been so much before the public of late, that the following tables of distances will not be unacceptable:—

	MILES.
From Bombay to Aden	1646
„ Aden to Suez	1323
„ Bombay to Socotra	1137
„ Socotra to Camaran	835
„ Camaran to Cossair	795
„ Cossair to Suez	270

	MILES
From Alexandria to Malta	837
„ Suez to Quaherah	70
„ Quaherah to Alexandria	120
„ Suez to Boulac	80
„ Boulac to Alexandria	185

	DAYS.
Falmouth to Malta, with 2 days at Gibraltar	16
Delay at Malta	2
Malta to Alexandria	6
Alexandria to Suez	6
Suez to Aden	8½
Delay at Aden for coals	2
Aden to Bombay	10½
	51

Compare this with the route by Cossair:—

	DAYS.
Bombay to Aden	10½
Delay at Aden	2
Aden to Cossair	6¾
Cossair to Coptos	4
Coptos to Boulac by water	8
Boulac to Alexandria	3
	34¼

(*Wilkinson's Thebes.*)

The number of days from England to Alexandria being 24, it appears, from these computations, that the route from Alexandria to Bombay, by Suez, would occupy 27 days, while by Cossair it would require 34½ days; but if steam boats were employed on the Nile between Coptos and Alexandria, instead of the country boats as at present, the latter route might be reduced to 29 days. The line by Suez, therefore, has the advantage, even if this improvement were made. We are inclined to recommend this mode of communication as possessing advantages which neither the route by the Nile or Euphrates possess. The latter will be attended with almost insuperable difficulties, and appears to us chimerical in the present barbarous state of the country.

X.—*Botanic Garden in Japan.*

THE Dutch government has formed a botanic garden at Dogima in Japan, which according to Dr. Siebold, contains more than a thousand plants, collected from the Japan islands and from China. In the garden, a memorial has been erected in honour of Cämpfer and Thunberg. The students who were instructed by Thunberg during his travels in Japan, have followed up the study of botany with much zeal and assiduity. They study the science, particularly in reference to its application to medicine.

Dr. Siebold gives instruction on medical botany, which is eagerly sought after by the Japanese. He praises the aptness of the Japanese in distinguishing plants. Sigi Letsyemon, the interpreter of Thunberg, left a son and grandson, who possess a herbarium which was made by their ancestor with the aid of Thunberg. They possess a diploma, granted after a strict examination. The Japanese keep up a constant commerce with the Chinese; and obtain most of their showy plants from China.—(*Wickstrom's Jahrsbericht der Botanik*, 1831. 145, *and Brandes' Pharm. Zeit.* 1835, 2.)

XI.—*Phloridzin, a new Substance.*

Konninck and Stas give this name to a substance which they have found in the bark of the wild apple, pear, plumb, and cherry. It possesses a yellowish white colour, crystallizes in silky needles, has at first a bitter and then astringent taste. It is soluble in water, very soluble in alcohol and ether, without action on test paper; soluble without decomposition in concentrated sulphuric and muriatic acids. The sulphates of iron colour its solution in water deep brown, acetate of lead produces a copious white precipitate. Lime water, ammonia, tartar emetic, corrosive sublimate, and isinglass have no action on Phloridzin.—(*Journ. de Chim. Medic* i. 259, NS.)

XII.—*Greatest ascents in the atmosphere.*

M. Boussingault, in company with Colonel Hall, on the 16th of December, 1831, ascended Chimborazo, to the height of 6,006 metres (19,699 feet) the greatest elevation which has yet been attained on land, Humboldt having been able to reach as high only as 19,400 feet. M. Gay Lussac, in a balloon, rose to 22,900 feet at Paris. The barometer carried by Boussingault fell to 13 inches 8 lines. The temperature in the shade was 7·8 C (45·6° F.) This chemist thinks it possible to live in rarified air. Thus, at a height almost equal to that of Mount Blanc, where Saussure had scarce strength to consult his instruments, young women may be seen in South America, dancing during the whole night. The celebrated battle of Pinchinca during the war of independence, was fought at a height, little inferior to that of Mount Rose. The guides who accompanied Saussure, assured him, that they had seen the stars in broad day. Boussingault never witnessed them, although he reached a much greater altitude. (*Journ. de Chim. Medic.* i. 33. NS.)

XIII.—*Diamonds in Africa.*

Pliny says in his natural history, (lib. xxvii.) that the diamond existed in mines in Æthiopia, between the temple of Mercury and the island of Meroe. This precious stone was an article of traffic between the Carthaginians and Etrurians. Heeren stated, that it was brought by caravans from the interior of Africa, being extracted from the earth in mines or from auriferous sand. According to M. Vellecotte, an officer in the 16th French regiment, lying at Algiers, and M. Peluzo, Sardinain consul at Algiers, diamonds exist in the auriferous sand of the river Wa del Kebir or Kumel (Ampsaga of the ancients) which rises at the north-east extremity of the chain of Atlas. The diamonds were found in November, 1833, near the town of Constantine (the ancient Eitra.) M. Peluzo sent three of these diamonds to France. They are now in different collections. One of them is in the collection of the Royal School of Mines. Another, in the museum of Natural History, and a third, in a large private collection—(*Brandes' Pharmaceutische Zeitung*, 1835. 9.)

Meteorological Journal,

pt at the Manse of the Parish of Abbey St. Bathan's, Berwickshire, Lat. 55° 52′ N. Long. 2° 23′ W. at the height of about 450 feet above the sea. By the Rev. John Wallace.

APRIL.

DATE.		THERMOMETER.				HYGROMETER (Leslie's.)				BAROMETER. At 32° of Fahrenheit.				Rain in Inches. Weekly.	Direction of Wind at X. A.M.	REMARKS.
1835.		IX. A.M. °	IX. A.M. °	III. P.M. °	X. P.M. °	IX. AM °	X. AM °	III. PM °	X. PM °	IX. A. M.	X. A. M.	III P. M.	X. P. M.			
We.	1	48¾	52	55	47¾	8	8	15	8	29·212	29·212	29·172	29·172	·300	S. S. W.	A.M. overcast and calm, rain, P.M. overcast, with frequent gusts of wind.
Th.	2	55¼	59½	41	38	16	26	8	8	29·192	29·204	29·290	29·328		S. S. W.	A.M. sky overspread with white clouds, P.M. overcast, easterly wind, rain.
Fr.	3	38	39½	40	37	10	14	11	15	29·389	29·402	29·433	29·535		E. by N.	Overcast, strong wind, with frequent showers.
Sa.	4	42¼	43½	41¾	38	17	21	14	8	29·675	29·681	29·683	29·724		E. S. E.	Overcast, with slight showers, evening rain.
Su.	5	46½	46½	46½	42½	16	20	18	10	29·732	29·737	29·733	29·767		S. E.	Calm, A.M. partially clear, P.M. cloudy and lowering.
Mo.	6	52¾	5	56¾	47½	11	15	12	15	29·734	29·725	29·709	29·737		W. S. W.	Calm interrupted by occasional gusts, sky overspread with hazy clouds.
Tu.	7	50	52¾	51¾	46½	16	19	17	6	29·704	29·707	29·667	29·651		S. W.	Brisk wind with hazy clouds.
We.	8	53¾	54	54¼	47½	22	23	31	18	29·536	29·551	29·499	29·425	·000	W.	Strong wind, soft clouds in rapid motion, occasionally in black dense masses.
Th.	9	55½	57	54½	45¼	28	31	33	8	29·268	29·268	29·270	29·295		W.	Heavy gale, partially clear, cirrostratus, soft clouds below in rapid motion.
Fr.	10	45½	46	48½	40	31	33	34	23	29·603	29·627	29·650	29·719		W. N. W.	Gentle wind, evening calm, (sometimes interrupted) fleecy clouds in motion.
Sa.	11	41¾	42½	45	39¾	28	31	35	17	29·896	29·906	29·881	29·799		N.	A.M. gentle wind, P.M. calm, nearly cloudless, sky overspread with thin haze
Su.	12	47	49	51	43½	21	23	29	11	29·671	29·682	29·607	29·573		W.	Calm, overcast, cirrostratus, soft clouds below, Noah's ark northwd. to southwd.
Full M. Mo.	13	49½	52	53	44½	20	26	37	11	29·550	29·554	29·523	29·516		W. by S.	A.M. fine, gentle breeze, floating cumuli, P.M. heavy clouds with brisk wind
Tu.	14	53	51	51	47½	27	30	23	15	29·402	29·426	29·546	29·316		W. by S.	Brisk wind, partially clear, with large masses of cumuli.
We.	15	39	39¼	41¼	31½	30	32	26	17	29·422	29·443	29·521	29·717	·250	N. W.	A.M. brisk wind, floating cumuli, P.M. wind shifting N.N.E. snow showers.
Th.	16	31	34	35¾	32	8	9	12	8	29·679	29·678	29·708	29·717		N.	Heavy showers of snow and hail, brisk wind.
Fr.	17	35¾	37	39¾	38½	20	23	26	11	29·783	29·783	29·724	29·647		N. W.	Calm, cloudy, occasionally overcast.
Sa.	18	46	49½	45¼	37½	13	19	10	8	29·437	29·429	29·502	29·653		N W by W	A.M. brisk wind, cloudy, frequent showers, P.M. cloudy, evening overcast.
Su.	19	42½	44	51	45	8	14	33	11	29·772	29·781	29·772	29·815		W.	Calm, cloudy or overcast, tendency to rain.
Mo.	20	50	50	53	49½	25	22	30	19	29·793	29·793	29·751	29·746		W. S. W.	Lightly cloudy, with brisk unsteady wind.
Tu.	21	51	53¼	54	42	25	12	30	19	29·678	29·666	29·688	29·804		W. by S.	Brisk unsteady wind, noon overcast, tendency to rain, evening calm and clear.
We.	22	48	48¾	49	43½	33	36	28	12	29·872	29·884	29·877	29·877	.360	W. N. W.	Light wind, A.M. nearly cloudless, P.M. overcast.
Th.	23	53½	54¾	59	47½	28	33	50	8	29·849	29·838	29·828	29·890		N W by W	Brisk wind, clear and fine, cumuli.
Fr.	24	56	54¾	56	41¼	36	36	28	18	29·843	29·824	29·719	29·628		N W by W	Gentle breeze, A.M. cloudy, P.M. partially clear, evening clear, wind rising.
Sa.	25	44½	45¾	47½	37½	39	42	42	20	29·486	29·458	29·328	29·353		N. W.	A.M. sky overspread with a thin hazy whiteness, P.M. heavy clouds, showers.
Su.	26	37½	38½	41¼	35¼	20	28	35	6	29·314	29·450	29·215	29·101		N. N. W.	Brisk wind, heavy clouds, with snow and hail showers, evening boisterous.
Mo.	27	37	38½	42	38¾	9	1	17	10	29·177	29·198	29·263	29·351		N. E.	Brisk wind, A.M. snow and hail showers, P.M. heavy masses of cloud.
Tu.	28	43¼	44½	44¾	41½	18	19	21	13	29·444	29·456	29·479	29·543		N W by N	Cumuli floating over a blue sky, brisk wind, evening calm and overcast.
We.	29	43¾	44¾	43¾	40	20	20	21	9	29·601	29·618	29·601	29·598	·000	E. by N.	Heavy clouds floating over a blue sky, P.M. brisk wind increasing, evg. clear
Th.	30	46	47	43¾	40	25	26	17	11	29·492	29·480	29·437	29·415		E.	A.M. sky overspread with a thin white cloud, (cymoid formation) strong gale.
Means.		46·1	47·5	47·9	41·5	21	23	25	12	29·573	29·582	29·560	29·580	·910		Means for the Month { Therm. 44·¾° Hygr. 20·¼ Bar. 29·573. } Mean temperature of spring water 43° Mean point of deposition 33·7° Moisture in a cubic inch of air = ·001447 gr.

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ERRATA.

p 20, *l* 3 and throughout, for Almeyda, *read* Almaden. *p* 31, *l* 21, for nine, *read* 5½. *p* 31, *l* 30, for somewhat more than half, *read* about one-third. *p* 77, *l* 34, for Corniferæ, *read* Coniferæ. *p* 93, *l* 3, for while, *read* white. *p* 97, *l* 24, for 52, *read* 50. *p* 104, *l* 19, for 44, *read* 21. *p* 117, *l* 16, for insoluble, *read* soluble. *p* 130, *l* 17, for 2·563, *read* 1·99. *p* 158, *l* 38, for 300, *read* 3000. *p* 218, *l* 6, for Neotna repettis, *read* Neottia repens. *p* 239, *l* 1, for microcoscopal, *read* microscopical. *p* 285, *l* 10 from bottom, for immediately, *read* intimately. *p* 287 *l* 1, for dried, *read* tried, *p* 359, *l* 28, for length, *read* levity. *p* 361, *l* 5, for down, *read* between. *p* 361, *l* 26, for direction, *read* division. *p* 363, *l* 9, for noise, *read* note. *p* 367, *l* 27, for annexed, *read* annealed. *p* 370, *l* 4 from bottom and throughout, for Alsten, *read* Alston. *p* 393, *l* 4 from bottom, before Macroglossa, insert *Deilephila Galii*, hovering like.

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